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Progress Report on the Regulatory Cooperation Program between the Norwegian Radiation Protection Authority and the Federal Medical Biological Agency of Russia

Projects and other Activities Completed in 2008–2009 and Plans for 2010–2011

Statens strålevern
Norwegian Radiation Protection Authority

Reference:
Roudak S F, Sneve M K, Kiselev M , Shandala N K. Progress report on the regulatory cooperation program between the Norwegian Radiation Protection Authority and the Federal Medical Biological Agency of Russia. Final report of projects and other activities completed in 2008–2009 and plans for 2010–2011. StrålevernRapport 2011:7. Østerås: Norwegian Radiation Protection Authority 2011.

Key words:
Radiation protection regulations, remediation of contaminated area, 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.

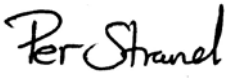
Abstract:
This report describes work carried out in 2008–2009 under the NRPA – Federal Medical-Biological Agency regulatory support program. It focuses on development of improved regulatory documents and supervision of remediation activities due to be carried out at Andreyev Bay, Saida Bay and Gremikha in Northwest Russia. The work program for 2010–2011 is also introduced.

Referanse:
Roudak S F, Sneve M K, Kiselev M, Shandala N K. Progress report on the regulatory cooperation program between the Norwegian Radiation Protection Authority and the Federal Medical Biological Agency of Russia. Final report of projects and other activities completed in 2008–2009 and plans for 2010–2011. StrålevernRapport 2011:7. Østerås: Statens strålevern 2011. Språk: engelsk.

Emneord:
Strålevernregulering, opprydning av kontaminerte områder, brukt kjernebrensel, radioaktivt avfall, kontroll- og beskyttelsessoner, radiologisk overvåking, strålevern for personale, effektive stråledoser, beredskap.

Resymé:
Rapporten beskriver arbeid som ble gjennomført i 2008–2009 som en del av Strålevernets og FMBAs myndighetssamarbeid. Arbeidet fokuserer på utvikling av normative dokumenter og tilsynsprosedyrer under oppryding av anleggene i Andrejevbukta, Sajdabukta og Gremikha i Nordvest- Russland. Rapporten beskriver også arbeidsprogrammet for 2010–2011.

Head of project: Malgorzata K. Sneve
Approved:



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Progress Report on the Regulatory Cooperation Program between the Norwegian Radiation Protection Authority and the Federal Medical Biological Agency of Russia

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A Collaborative Project of the

Norwegian Radiation Protection Authority

and

Federal Medical Biological Agency

Statens strålevern

Norwegian Radiation
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Østerås, 2011

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This report sets out the progress made in the projects and related activities carried out in the period 2008 – 2009 within the Regulatory Cooperation Program between the Norwegian Radiation Protection Authority and the Federal Medical Biological Agency of Russia. The progress described follows directly from previous work carried out within the Regulatory Cooperation Program, as set out in earlier NRPA reports and in accordance with the Norwegian Government's Plan of Action to improve nuclear and radiation safety in Northwest Russia. The work was carried out by specialists of the Burnasyan Federal Medical Biophysical Centre, with support from other Russian organisations and specialists as well as experts from the NRPA.

Five main projects are described, each of which has contributed to the improvement of regulatory supervision by the FMBA over the sites operated by SevRAO in the Northwest of Russia, including the Sites for Temporary Storage at Andreyev Bay and Gremikha, and the Regional Centre for Waste Conditioning and Long-term Storage at Saida Bay. The main activities of interest include recovery and secure the safe condition of spent nuclear fuel and radioactive waste from inadequate storage facilities and ensuring their continued future safe storage.

The topics covered by these projects include:

- Control of Occupational Exposure and Optimisation During Hazardous Operations through the Development of Databases on Radiation Situation and Individual Occupational Exposure (DOSEMAP)

  The software for a mapping database of radiation situation parameters at SevRAO Facilities has been developed. A computer scheme of workshops in new Complex facilities for the spent nuclear fuel and radioactive waste management, the design of which is already available, has been developed. The software for the database on individual doses to the SevRAO workers has also been developed. Two draft guidance documents have been prepared: «Application of the database on the radiation situation parameters and database on individual doses to workers for arrangement and performance of radiation hazardous operations» and «Application of the database on the radiation situation parameters and database on individual doses to workers to regulate radiation protection of workers»

- Mapping of Contamination at Andreyev Bay for the Purposes of Remediation Planning (DATAMAP)

  Over 2008-2009, a geo-informational system was developed under the DATAMAP project for the purpose of technical support during the regulatory supervision of sites under remediation. As a result, a computer based system has been developed to facilitate visualization of the radiation measurements on the STS site, interpolate the obtained data over the full STS area, estimate the interpolation error, specify the sufficiency of data and identify areas for additional measurements implementation. Moreover, the system provides a function of data comparison and visualization with the criteria established in the Guidance R 2.6.1. 25 - 07 «Criteria and norms of remediation of sites and facilities contaminated with man-made radionuclides, FGUP SevRAO». The system may now be tested in areas where remediation is in progress.

- Training on Radiological Protection of Personnel of the Ostrovnoy Branch of SevRAO and the Population of Gremikha Village in the Event of Emergency (Emergency Training)

An emergency training exercise on radiological protection of the personnel from the SevRAO Facility "Ostrovnoy" and the population of Gremikha village was conducted in June 2009 with support of the Norwegian Radiation Protection Authority. This demonstrated the effectiveness of the emergency response system under the FMBA of Russia and communication between the response organizations under the State Atomic Energy Corporation "Rosatom" in case of a radiation accident. An important result of the training was an opportunity to inform the public and population about the operator and regulator efforts aimed at radiation protection assurance and at keeping preparedness and sufficient resources for the emergency mitigation in the region. It was also a very useful exercise because of the involvement of the many agencies involved in emergency preparedness and response. It was noted that remote places with weak transportation options like Gremikha present special challenges regarding the qualification improvement of medical personnel and the system of analytical expertise. These can be addressed by using modern communication equipment and operation of emergency centres of FMBA of Russia.

- Performance Reliability Monitoring (PRM)

Under the Performance Reliability Monitoring project, a pilot version has been developed for an expert-and-diagnostic information system for risk monitoring of the performance reliability violation of workers involved in the spent nuclear fuel management ("EDIS_STS"). It is designed to support identification of workers with potentially weak performance reliability. Using the developed methods, the hardware and the software systems for monitoring and analysis, specialists can work within a protocol of medical and psycho-physiological examinations to compare findings of clinical and prenozological examinations in real time and, if necessary, prescribe remedial actions.

- Radiation Protection Requirements for Storage of Radioactive Waste

In order to implement effective radiation protection and supervision of safe radioactive waste management in Northwest Russia, new regulatory guidance was developed on "Requirements for Protection of Workers, Public and Environment during Arrangement of Radioactive Waste Management in the Centre for Conditioning and Long-Term Storage at the Federal State Unitary Enterprise SevRAO". The regulatory document developed takes into account the special features of waste management in Northwest Russia, resulting from implementation of programs aimed at nuclear legacy mitigation. This document specifies the radioactive waste management procedure during their long-term storage, regulates the requirements for safety assurance at different stages of the radioactive waste preparation for their long-term storage, including gathering and sorting in compliance with the established classification, package, transportation, treatment, conditioning and storage.

An important feature of the work has been the under-pinning science which supports regulatory activities. Accordingly, the program has included workshops involving participants from international and other national agencies, as well as presentation of papers at conferences, and the production of peer reviewed papers for publication in scientific journals.

Progress in these projects has been substantially enhanced through interaction with experts and regulatory authorities in other countries, as well as close links with operators, both in Russia and elsewhere. The next stage of the Russian-Norwegian regulatory cooperation program focuses on practical application of the enhanced regulatory regime which has been prepared, supported by the work described above. This is especially important as the most important spent nuclear fuel and radioactive waste operations and site remediation activities will be implemented in the coming years. Several projects have therefore been initiated in 2010 to address these issues. The overall objectives are to ensure that remedial activity in Northwest Russia is carried out consistently within the Russian

Federation regulatory framework, taking into account international guidance and recommendations, as well as good regulatory practice from other countries, in so far as they are relevant to the Russian Federation. The intention is that regulatory supervision should be carried out efficiently, to assist the timely and effective implementation of industrial projects and promote a developing and enhanced safety culture. A special focus will be to support regulatory bodies in the regulation of remediation activities at the nuclear legacy sites.

List of acronyms and abbreviations:

ARSMS	Automated Radiation Situation Monitoring System
BDS	Blocks of Dry Storage
CCLS	Centre for Conditioning and Long-term Storage, Sayda Bay
CD, ES and FS of Murmansk region	Department on civil defense, emergencies and fire safety of Murmansk region
CH&E № 120	Centre for Hygienic & Epidemiology № 120
EC	European Commission
ETS	Emergency Technical Centre
EDIS_STS	Expert-and-Diagnostic System of risk monitoring of performance reliability violation of workers involved in the SNF management
EMRDC	Emergency Medical Radiation Dosimetry Centre
EWN GmbH	Energiewerke Nord GmbH, Germany
FMBA of Russia	Federal Medical-Biological Agency of the Russian Federation
FMBC	Burnasyan Federal Medical Biophysical Centre
FSUE	Federal State Unitary Enterprise
GIS	Geo-Informational System
HPZ	Health Protection Zone
IAEA	International Atomic Energy Agency
MSCh	Medical Sanitary Unit
NPP	Nuclear Power Plant
NRPA	Norwegian Radiation Protection Authority
OTSPN	Organizational-and-technical system for the performance assurance, SevRAO
PRM	Performance Reliability Monitoring
RM	Regional Management
RSLS	International Working Forum for Regulatory Supervision of Legacy Sites
RW	Radioactive Waste

SA	Supervised Area
SevRAO	Northern Federal Unitary Enterprise on Radioactive Waste Management
SNF	Spent Nuclear Fuel
STS	Site of Temporary Storage for spent fuel and radioactive waste, formerly designated as Shore Technical Bases
WBC	Whole Body Counter
ZLN	Zwischenlagers Nord in Lubmin, Germany

1 Introduction

This report sets out the progress made in the projects and related activities carried out in the period 2008 – 2009 within the Regulatory Cooperation Program between the Norwegian Radiation Protection Authority (NRPA) and the Federal Medical Biological Agency of Russia (FMBA of Russia). The work described follows directly from previous activities carried out within the Regulatory Cooperation Program, as described in earlier NRPA reports, and in accordance with the Norwegian Government's Plan of Action to improve nuclear and radiation safety in Northwest Russia [1, 2, 3].

Five main projects have been completed during the period, each of which has contributed to the improvement of regulatory supervision by the FMBA over the sites operated by the Northern Federal Unitary Enterprise on Radioactive Waste Management (SevRAO) in Northwest Russia, i.e. the Sites for Temporary Storage (STS) at Andreyev Bay and Gremikha, and the Centre for Conditioning and Long-term Storage (CCLS) at Saida Bay. The main operations of interest planned at these sites include recovery and secure the safe condition of spent nuclear fuel (SNF) and radioactive waste (RW) from inadequate storage facilities, and ensuring their continued future safe storage.

The work was carried out by specialists of the Burnasyan Federal Medical Biophysical Centre (FMBC), with support from other Russian organisations and specialists as well as a strong cooperation with SevRAO and Rosatom.

The topics covered by these projects are described in the next five sections of this report, and include:

- Control of Occupational Exposure and Optimisation During Hazardous Operations through the Development of Databases on Radiation Situation and Individual Occupational Exposure (DOSEMAP);
- Mapping of Contamination at Andreyev Bay for the Purposes of Remediation Planning (DATAMAP);
- Training on Radiological Protection of Personnel of the Ostrovnoy Branch of SevRAO and the Population of Gremikha Village in the Event of Emergency (Emergency Training);
- Performance Reliability Monitoring (PRM); and
- Radiation Protection Requirements for Storage of Radioactive Waste.

A significant feature of the program has been the involvement of international agencies and other national organisations and experts, to provide advice and review taking account of international recommendations and experience from regulatory supervision of nuclear legacy sites in other countries. A further important feature of the work has been the under-pinning science which supports regulatory activities. Accordingly, the program has included workshops involving participants from international and other national agencies, as well as presentation of papers at conferences, the publication of information material, and the production of peer reviewed papers for publication in scientific journals. These additional activities are described in Section 7.

Section 8 records discussion and overall conclusions relating to the current status of the cooperation programme and Section 9 describes the objectives and topics for future projects under consideration within the continuing programme of activities.

References are given at the end of each Section.

1.1 References for section 1

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2 Development of Databases on Radiation Situation and Individual Occupational Exposure at Sites of Temporary Storage

In 2005-2006, as a part of the previous cooperation program with NRPA, specialists from FMBC carried out examination of the radiation situation at the blocks of dry storage (BDS) locations 2A, 2B, 3A, and in Building 5 at Andreyev Bay. The measurements showed that external gamma dose rate levels there are tens or hundreds of times greater than those typical in nuclear power industry facilities. The calculated acceptable work duration of the personnel within the industrial rooms of building 5 and BDS is very limited, based on the requirement to keep effective dose to workers within appropriate limits.

According to international practice when solving problems relating to radiation safety assurance under such conditions, the remediation process is subdivided into technological stages, where each next stage takes into account the experience obtained in the previous stage. The main objective of each stage of implementation is to reduce risk gradually both for workers and the public.

Investigations and developments for the period from 2008 to 2009 were aimed at continued improvement of optimization for radiological protection of personnel at the stages of planning and operation of new Combines for SNF management and RW processing. The detailed work plan was developed based on the results of the previous measurements, recommendations and guidance [1, 2, 3, 4, 5], the basic requirements on radiation safety [6], and progress with the industrial projects for remediation of the STS.

2.1 Objectives and scope

The general objective of DOSEMAP was to create a regulative and guidance basis to optimize radiation protection of workers during large-scale operations of SNF management and of RW treatment, taking into account special features of these operations performance under real SevRAO conditions and in compliance with requirements of the relevant international regulations and rules.

The Databases developed within the project were developed to be used by the regulatory bodies in the course of their review of both the implementation of the design solutions on construction and operation of new Combines at SevRAO facility 1 (Andreyev Bay), and the radiation hazardous operations of RW and SNF management. The operator is also intended to use the Databases for planning and implementating radiation hazardous operations at SevRAO facilities 1 and 2 (Gremikha).

2.2 Main tasks and activities

The main Tasks and activities within the project were carried out in the following sequence:

1. Software specification and developments for the Mapping Database on radiation situation parameters on-site and in workshops of SevRAO facility 1.
2. Development of software for the Dose Database on individual doses to workers of SevRAO facilities 1 and 2, and the Mapping Database at SevRAO facility 2.
3. Arrangement of the Mapping Database of radiation situation parameters in functioning workshops of STS (Andreyev Bay). Development of computer scheme of the main workshops under design and construction in new Combines for SNF and RW management.
4. Arrangement of the Dose Database on individual doses to workers of SevRAO facility 1. Software development for the Mapping Database on radiation situation parameters on-site SevRAO facility 2.

5. Development of methodic documents for the radiation protection regulatory bodies and for SevRAO leaders, including

    - Development of guidelines for the radiation protection regulators (RD 120 of FMBA of Russia) on application of the developed databases in the course of occupational dose optimization.
    - Preparation of recommendations for SevRAO facility 1 and 2 leaders on application of the developed databases in the course of planning and optimization of radiation hazardous operations.

2.3 Discussion and recommendations

According to the detailed Project Plan, for 2008, Terms of Reference for the Dose Database on radiation situation and the database on individual doses to workers of the SevRAO facilities 1 and 2 were drafted and reviewed in discussion with the regulatory bodies – FMBA of Russia and Regional Management 120 under the FMBA of Russia – and with the SevRAO.

The software for the Mapping Database for on-site facility 1 was developed, and draft version of its specification was made. To develop the mapping database, the system of retrospective and predictive assessment of external doses «ROCKVILLE» was used. It was based on the experience of the software development for a system of retrospective assessment of external doses to workers and to the public following the Chernobyl NPP accident. The «ROCKVILLE» system is able to be further developed and have extended its regulative information base. Any user can extend a set of maps, workshop schemes, and data on the radiation situation himself/herself; he/she can also change the amount of checkpoints. To assure the stable information keeping in case of abnormal situations, planning and observance of the regulation of the Databases, periodic copying by using the standard system tools was adopted.

The possibility of worker exposure during their work in those workshops serves as a basis to develop the Mapping Database. According to the agreement with the management of RD 120 of FMBA of Russia and "SevRAO" the functioning workshops were defined for which development of the computer scheme and introduction of the relevant measured parameters of the radiation situation was required.

The software for the Dose Database for SevRAO facility 1 was developed, and a draft version of its specification has been made. The Doses Database allows input and editing of data on exposure to workers, according to the card of individual doses account and also search for, output and print necessary data at the user's request. The Database allows time control of the effective and equivalent dose accumulation that promotes operational and efficient calculation of permitted dose to perform radiation hazardous and/or remedial operations.

The listing of the main functioning workshops of the STS at Andreyev Bay requiring development of the computer scheme was discussed and coordinated.

According to the detailed Project Plan for 2009 the Mapping Database on the radiation situation parameters in the functioning workshops (facility 1 at Andreyev Bay) was developed. The Rockville software specifies the radiation situation using the base-map background. It uses the Surfer program drawing tool.

The prime tool is the radiation situation data presentation in a plane using isodose curves, which are generated by means of interpolation of the known set of measured dose rate values (or contamination density, beta flux density etc.). The step of data presentation by isodoses may by arbitrary, including zero. In the last case we operate with the continuous spectrum of isodose values – so called «image». In addition to the plane one, the space data presentation is possible with ability to change a point of review in "on-line" mode. The third mode of data presentation is called «post» - presentation of measurement points and the associated values measured. In addition, the first derivations of the values interpolated can be displayed instead of the results of interpolation. There are no restrictions for

simultaneous output of several types of data presentation on the radiation situation, only the best demonstrativeness.

The full Database of the System is a set of independent Databases on the Subjects. For example, NPP, an enterprise, or SNF storage facility etc. can be considered as a Subject. Each Subject has its proper Database filled with many types of information, where the Mapping Database is a component. It contains data of two prime categories:

- Maps and plans of nature and constructive components of the Subject
- Values of the radiation situation parameters plotted on these maps and plans.

Computer scheme of workshops in new Complex facilities for the SNF and RW management, the design of which is already available, has been developed. Because operations on the design of Combines for the SNF and RW management are behind schedule, the full volume of computer maps of workshops in new Combines for the SNF and RW management will be developed in the course of future work at the DOSEMAP project.

The Dose Database B on individual external doses allows answering the following questions:

- Current doses to any worker at each moment since the beginning of the year;
- Current doses to workers of specified occupations at each moment since the beginning of the year;
- Current doses to workers (younger than 30 years) of specified occupations at each moment since the beginning of the year; and
- Doses to the abdomen area for women.

The DB on individual internal doses allows answering the following questions:

- Current internal doses to any worker at each moment since the beginning of the year;
- Current internal doses to workers of specified occupations at each moment since the beginning of the year; and
- Current internal doses to workers (younger than 30 years) of specified occupations at each moment since the beginning of the year.

The DB on individual effective (cumulative) doses allows answering the following questions:

- Current effective doses to any worker at each moment since the beginning of the year;
- Current effective doses to workers of special occupations at each moment since the beginning of the year;
- Current effective doses to workers (younger than 30 years) of specified occupations at each moment since the beginning of the year;
- List of workers of specified occupations from minimum dose values accumulated since the beginning of the year;
- Dose reserve (up to 20 mSv).

A computer map of the SevRAO facility 2 has been developed. Figure 1 shows the computer map of the industrial site of the SevRAO facility 2 (Gremikha). This map does not show the available checkpoints of the radiation situation parameters, because their amount is insufficient to predict doses to workers involved in operations on-site. Additional checkpoints of the radiation situation parameters will be coordinated with the Regional Management 120 FMBA of Russia and SevRAO facility 2. Specification of the mapping database on the radiation situation parameters on-site for facility 2 has been made. The full Database of the System is a set of independent Databases on the Subjects.

Figure 1. ***Computer map showing industrial buildings and constructions located on the industrial site of the SevRAO facility 2 (Gremikha).***

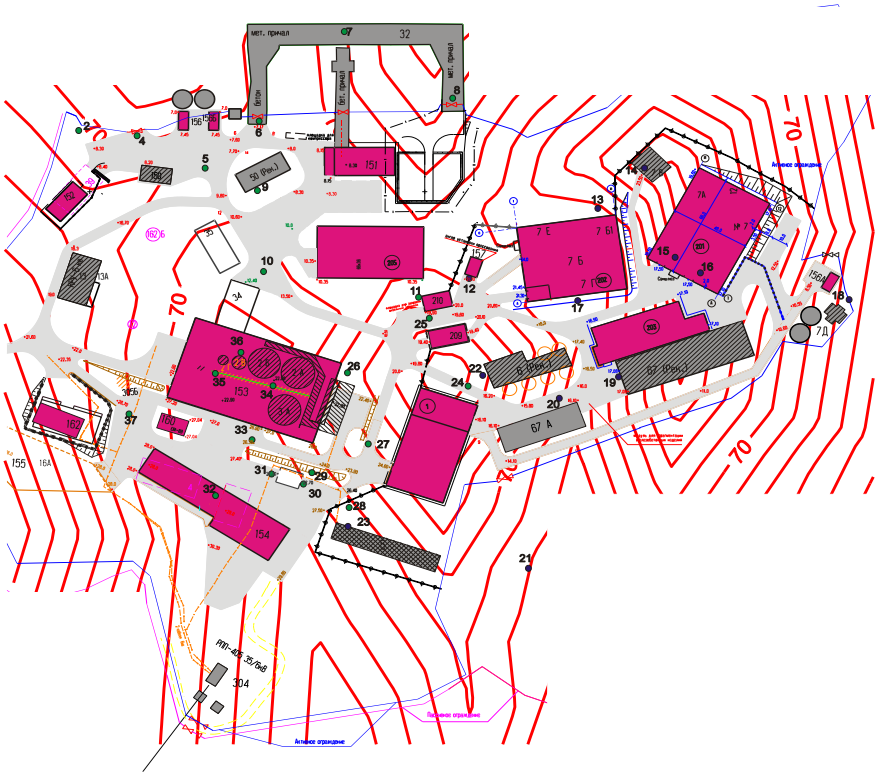

Figure 2. R***adiation situation at the industrial site of SevRAO facility 1 (Andreyev Bay)*** *(MAD values are conventional)****.***

Figure 2 shows the base-map and isodose curves at the industrial site of SevRAO facility 1 (Andreyev Bay). The isolines shown are the results of the ambient dose rate (MAD) values interpolation. Generally, interpolation is being performed using Kriging Method which predicts unknown values from data observed at known locations.
Figure 3 demonstrates that the radiation situation can be presented not only on a plane, but also in a three-dimensional space. An advantage of the last in comparison with the flat displaying is that such figure can be rotated on the screen in an arbitrary plane, to provide the best perspective view for the displaying analysis.

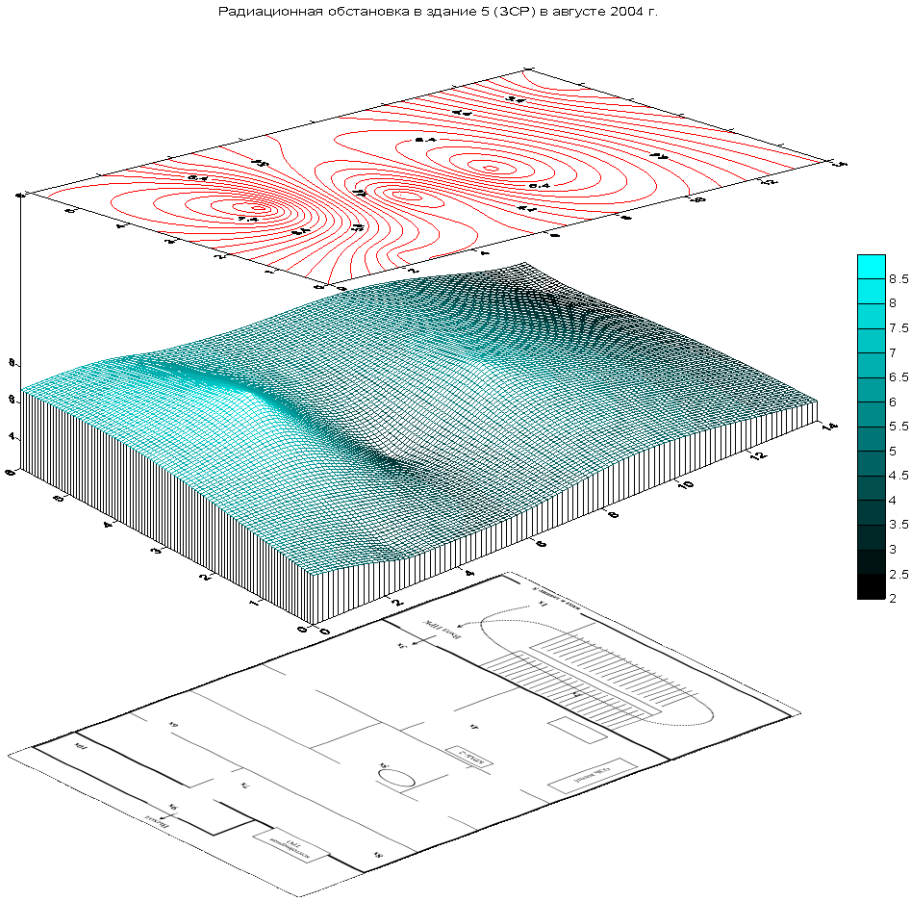

Figure 3. ***Radiation situation in Building 5 (Andreyev Bay). The base-map, the three-dimensional field of ambient dose rate and isolines of ambient dose rate*** *(MAD values are conventional).*

The Object is a set of Areas (Spaces).The Object can be presented by a single Space, or by a set of Spaces. In the latter case, some Spaces can either specify the particular fragments of the Object in addition to the general plan, or specify the Object as a set of elements without presentation of the general plan of the Object. Spaces are subdivided into scalable and sliced types.

The scalable Space is potentially associated with the multilayer and multitype map of the area specifying the whole Subject or its part, for example: the industrial site, control access area, area surrounding the contamination focus etc. In the course of operation using the scalable Space map, the user can switch both the scale layers with different degree of particularization and types of maps (plans, photo etc.). Generally, maps of the scalable Space consist of geographic map components imported from different global geo-information systems. The integrated map consists of a set of elements blocked in a rectangular fragment of land. Geographic coordinates (latitude, longitude) of borders of the separated fragment are the main characteristics of the scalable Space. Now, the system is able to use maps from two sources: Microsoft Virtual Earth and Google Satellite. In the future, involvement of fast progressing Yandex maps is envisaged.

The sliced Space is a group of Subspaces / Levels. Simple one-layer one-type map/plan relates to each Subspace. Typical example of the Sliced Space is a multistory building, a floor plan of which corresponds to Subspaces / Levels of the Sliced Space. In contrast with maps of the Scalable Space, maps/plans of Subspaces do not include geographic coordinates and are not oriented by the cardinal directions. They are lined off in units of length (m, km) and oriented only from consideration of comfortable treatment. Different Subspaces of the same Space can be oriented in different manners. The picture scaling is reached only by means of commands of the geographical system within the single layer, so its content must have the sufficient degree of particularization. As for the rest, manipulation with the Subspace of the Sliced Space is the same as that with the Scalable Space.

Draft Guidelines «Application of the database on the radiation situation parameters and database on individual doses to workers for arrangement and performance of radiation hazardous operations» have been prepared. These draft Guidelines define the application procedure of the information and analytical computer complex consisting of the Mapping Database and the Dose Database. The Guidelines are intended to be used by the radiation safety service of SevRAO facilities when planning and implementing radiation hazardous operations.

Draft Guidelines «Application of the database on the radiation situation parameters and database on individual doses to workers to regulate radiation protection of workers» have also been developed. These draft Guidelines define the application procedure of the same complex for the purposes of comprehensive application of the optimization principle during radiation hazardous operations of the SNF and RW management at the SevRAO facilities. The Guidelines are intended to be used by the radiation safety regulatory bodies (RM 120 FMBA of Russia).

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3 Computer Map Development of Radioecological Data on the Site of Temporary Storage at Andreyev Bay

In 2005-2007, the radioecological situation at the STS Andreyev Bay and Gremikha were assessed from a regulatory control perspective, as discussed in chapter 1 and in reference [1] . Criteria and regulation of the STS remediation were developed for three possible options of ecological remediation (conservation, conversion and liquidation) and the guidance of their application was also elaborated, as well as guidelines for radiation control and monitoring at different stages of the STS operation. A database on radionuclide contents in marine environmental media was also jointed together.

At the present time, the operator (SevRAO) is performing some urgent operations at the site of temporary storage (STS) of SNF&RW in Andreyev Bay under conditions concerning the degradation of containment barriers at the STS. These operations are aimed at making safe the site and hazardous buildings into accordance with regulatory requirements.

Up to now, a very large volume of information has been accumulated regarding the radioecological situation, public and environmental doses, radionuclide migration etc. In order to observe the changing radioecological situation, predict its further evolution, supervise and regulate under existing circumstances of STS remediation, the issues of summary, analysis and management of available radioecological information has become very important.

Development of the Geographical -Information System (GIS) to keep and retrospectively use all factual control and monitoring data was a logical continuation of the investigations completed in previous work based on application of the up-to-date computer technologies, as well as to provide automated information support of regulation and decision-making systems with respect to radiation protection during the STS remediation.

3.1 Objectives and scope

The objective of the DATAMAP project was to integrate all radioecological electronic data concerning STS in Andreeva Bay by means of arrangement of a GIS, intended for visualization and analysis of dynamics of space-time distribution of radioecological parameters. The proposed GIS was necessary to support FMBA in making regulatory decisions during remedial operations at the STS area. Such decisions concern the type and timing of implementation of methods for control and/or removal of radioactive contamination as well as decisions on waste disposal at Andreyev Bay.

The DATAMAP GIS consists of a system of “electronic” maps of STS area in Andreyev Bay and include data of radioecological measurements with coordinate relations between sampling (and/or measurement) points and the mapping database on the landscape, hydrogeology and geochemistry relating to the mapping base.

The DATAMAP GIS makes it possible:

- To perform detailed analysis of the current radioecological situation at the STS,
- To simulate and predict possible change of radioecological situation,
- To optimize the extent of radiation monitoring and remedial work.

3.2 Main tasks and activities

The main Tasks carried out within the project included the following:

1. Preparation of materials for inclusion in the GIS database

- Information gathering on radioecological data, landscape, hydrogeology and geochemistry, as well as how the data were gathered, as required for the mapping base, [2, 3, 4, 5, and 6];
- Performance of further site investigations of existing radioecological situation at the STS in Andreyev Bay;
- Preparation of materials relating to the map.

2. Databank development

    - Arrangement of user interface intended for entering and examining data, and for interfacing with the proposed GIS system;
    - Generation of the database on radioecological situation, landscape, hydrogeology and geochemistry;
    - Preparation of documentation for the database management;
    - Development of a technical and functional specification for the GIS to support final decision on choice of GIS software and how it will be applied.

3. Development of the application of the geoinformation system (GIS)

    - Putting markers of checkpoints on the mapping base;
    - Systematization of the resulting database information. Develop procedure for the system parameter verification;
    - Computer calculation of the main indexes for simulation and prognosis of radioecological situation. Trial application of simulation models and Input/Output arrangements for dynamic simulation presentation in the GIS.
    - Documentation for GIS management, including user manual preparation.

3.3 Discussion and recommendations

During this project, a study of the radio-ecological situation near the Andreyev Bay STS was carried out. All available information organizations who have made measurements at the STS site at Andreyev Bay were collected and analyzed in addition to findings of the radiation situation monitoring and control performed by the STS laboratories and CH&E-120 under the FMBA of Russia, including the FMBC measurements made in 2005/6 and 2008/9. During the measurement campaign of 2009 a comprehensive dosimetry study of the remedied site was carried out in addition to sampling and dose measurements at the reference points for radiation monitoring established in 2005.

The radioecological situation analysis near the Andreyev Bay STS over 2008/9 shows the following:

1. The radiation situation at the area of the STS Supervised Area (SA) remains practically the same in comparison with the previous years;
2. At the STS area not covered by remedial operations the radiation situation also remains practically unchanged;
3. In the remediated areas considerable reduction of gamma dose rate has been observed. Maximum effect was reached near the new pier, where the main radiation sources have been fully removed – contaminated slabs of the ex-pier the gamma dose rate became 1000 times lower. At the areas in close vicinity to the radiation hazardous facilities, the effects of the site remediation are less important. Probably this is connected to the fact that significant doserate

contribution at these territories is due to radiation of the sources located within the nearby radiation hazardous facilities, notably, the BDS facility as well as the solid and liquid RW storage areas.

4. The activity concentration of water from the STS water pipe was 0,04 Bq/l for ^{90}Sr and 0,32 Bq/l for ^{137}Cs. The mentioned values are much lower than the intervention levels for drinking water established in NRB-99 [7], but they are more than an order of the magnitude higher than values obtained in the 2005 and 2006 investigations (0,001- 0,009 Bq/l for ^{90}Sr and 0,01-0,02 for ^{137}Cs).
5. Over the period from January till September 2008, the activity concentrations of ^{90}Sr and ^{137}Cs were lower than the minimum detectable activity in all ground water samples, except for samples collected from boreholes No4100, No4092, No4071B, No4092, No4098 and 4092b.
6. Contamination of the marine environmental media (bottom sediments, seaweeds, seawater, and marine fish) with ^{90}Sr and ^{137}Cs practically remains at the level of the previous years. This means that additional contamination of the offshore waters with sewage and ground waters is trivial in comparison with contamination resulting from earlier STS activity (while it was a shore technical base) and from radiation accidents.

During 2009, a detailed gamma survey of the STS and SA areas was carried out (more than 2000 measurements) and soil samples were collected at the reference points for radiation monitoring.

All the radiation monitoring data for 2009 performed by the STS radiological laboratories have been put in the database.

The database consists of 7 interrelated tables. Seven tables keep radio-ecological information resulted from: the original studies (in the course of radiation monitoring performed by radiological laboratories of the STS and CH&E 120) and special radiation examinations performed by other institutions. These tables keep more than 4000 records in total.

The GIS database will be used to support decisions on radiation protection of the public and the environment during the STS remediation. The GIS database will permit analysis of:

- Data on the radiation situation (gamma dose rate, radionuclide contents in the environmental media);
- Soil contamination by the ground profile;
- Contamination of ground water;
- Prognosis of future contamination;
- Identification and presentation of areas over the whole map, for which contamination levels are above a pre-defined safety level;
- Identification of areas and locations where more data would be most valuable to improve accuracy of prognoses.

Such information would be very valuable in planning.

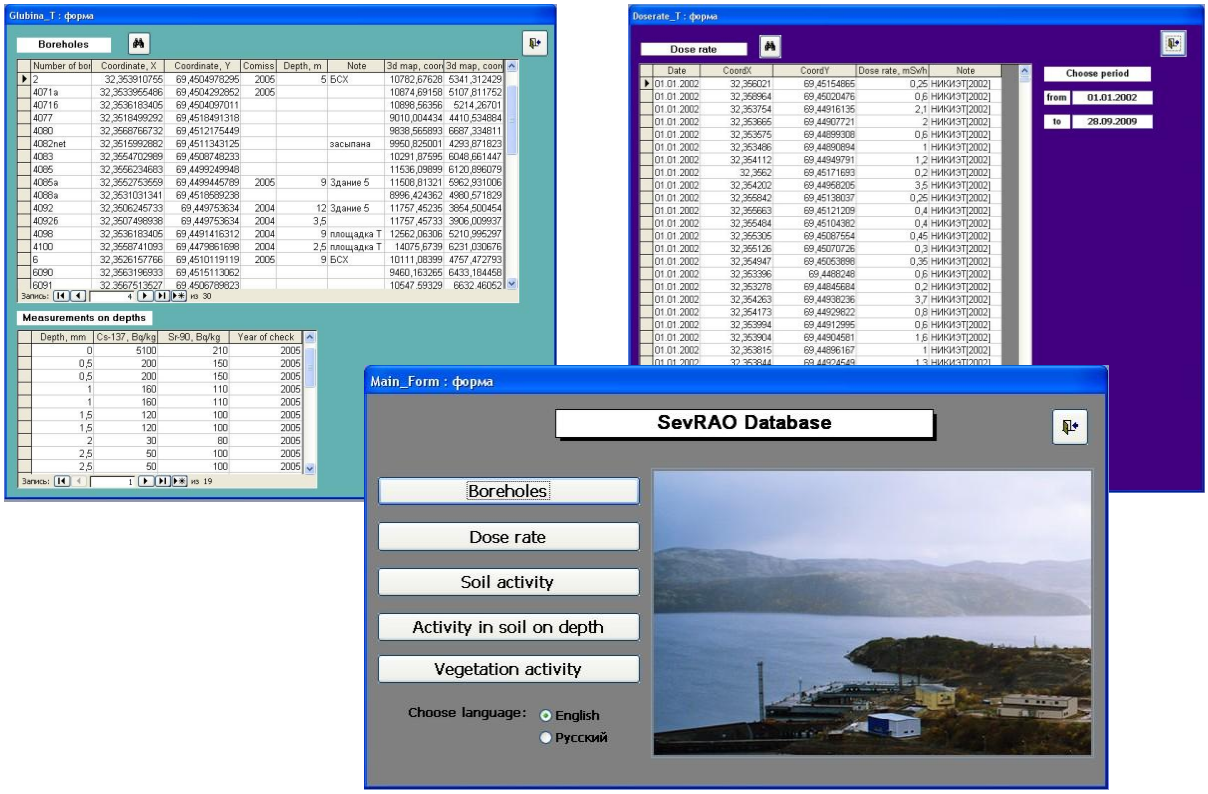

Figure 4. ***DATAMAP main menu for selection of radioecological data with illustration of stored gamma dose rate measurements*** *("Dose rate" section)* ***and activity concentrations of cesium and strontium in ground water on-site in the available boreholes*** *("Boreholes" section).*

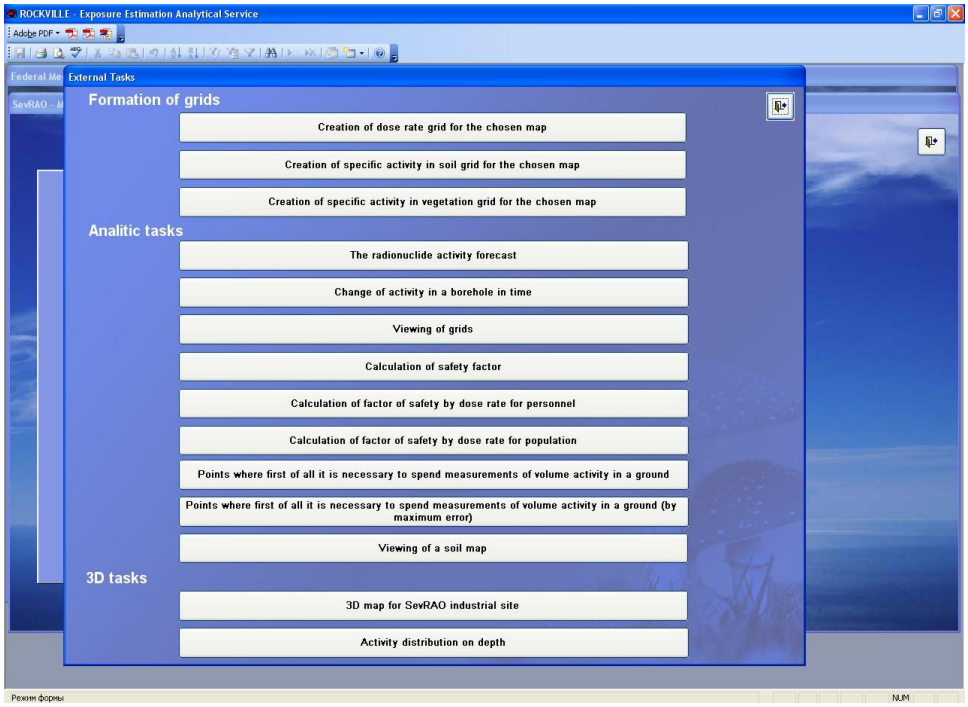

Figure 5. ***Illustration of main DATAMAP functions.***

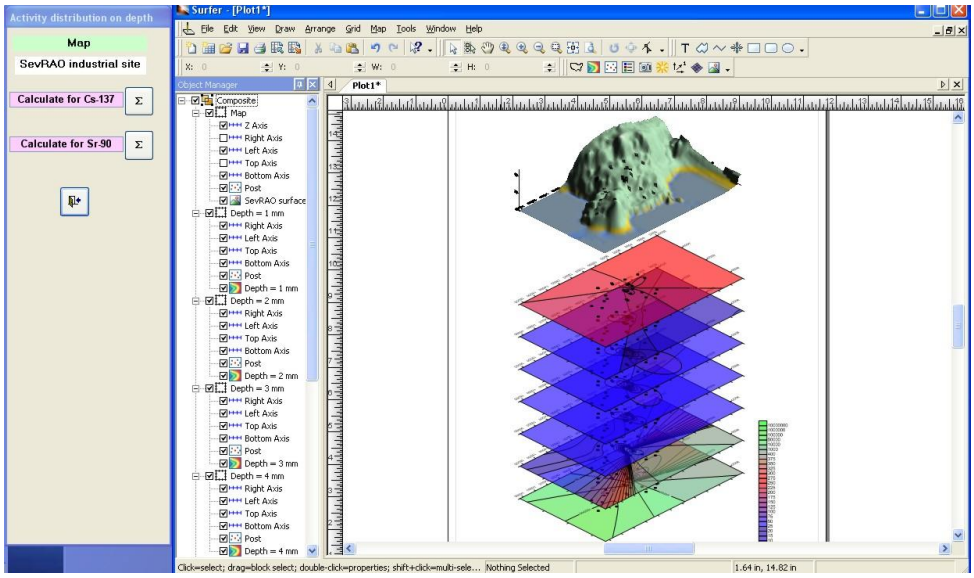

Figure 6. ***Three-dimensional plot of activity distribution over the borehole depth.***

To reduce errors of the dose calculation it is necessary to identify several specific points for additional measurements of the radiation situation. DATAMAP`s two ways of such calculation are based on search for areas with maximum gradient variation and on maximum error of interpolated value in point and measured data.

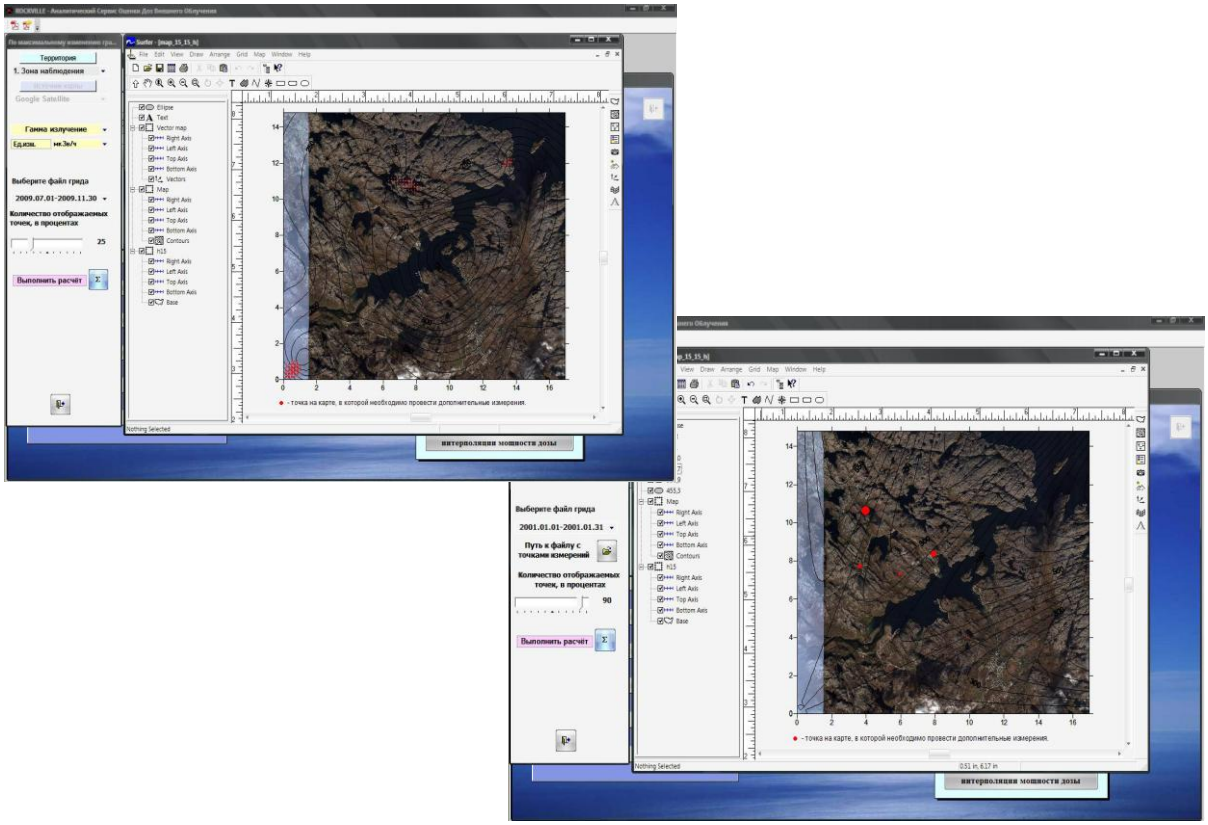

Figure 7. ***Identification of points for necessary additional measurements of the radiation situation.***

The software also permits to obtain points, where additional measurements of dose rate or activity concentration in ground must be carried out first to build iso-curves more precisely. The calculation result is graphically displaying the map with points (figure 8).

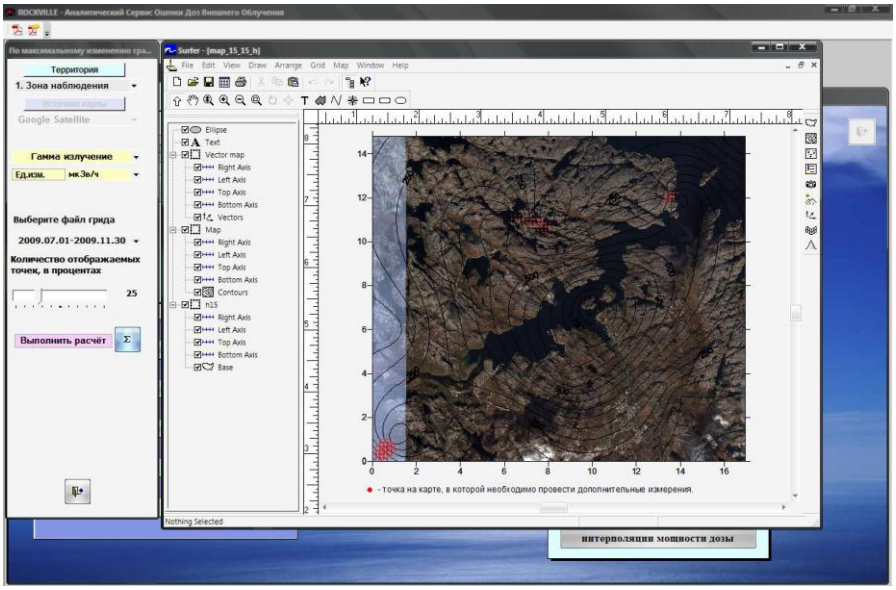

Figure 8. ***Illustration of DATAMAP function to identify critical areas for further measurement of dose rate or activity concentration in ground.***

The software permits to calculate areas for which the safety factor value is higher than 1. The calculation result presents graphically. Calculation of the safety factor can be made according to the gamma dose rate on-site or in terms of radionuclide specific activities in soil.

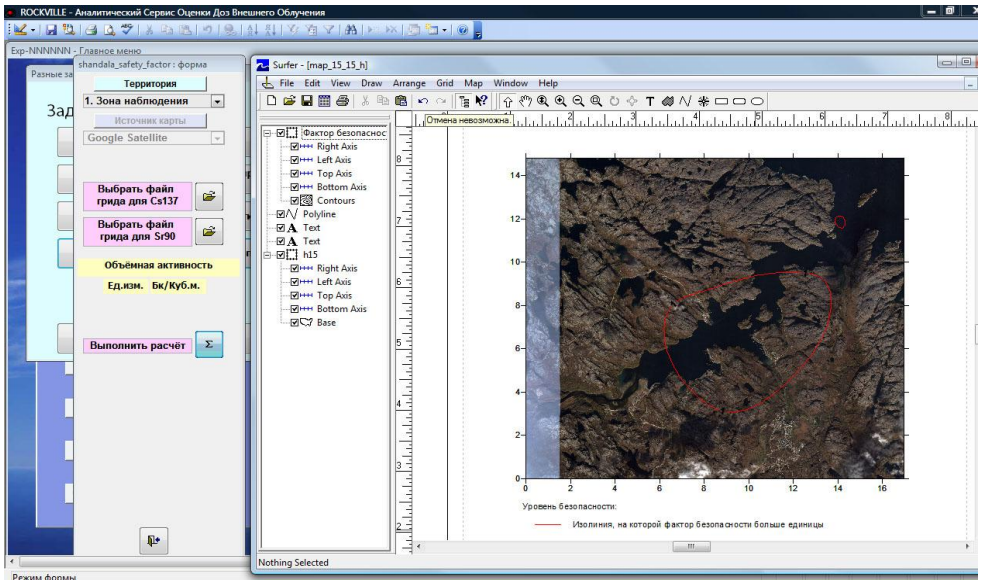

Figure 9. ***Identification and presentations of areas for which contamination levels are above a pre-difined the safety level.***

DATAMAP software is able to select optimum method for the grid building using measured data on the radiation situation. Measured dose results and topographic coordinates of the point of measurement are components of the input file. The software calculates median, mean, maximum and minimum errors, data interpolation during the grid building and recommends the method with minimum error and after that the operator makes the final selection based on the obtained data (figure 10).

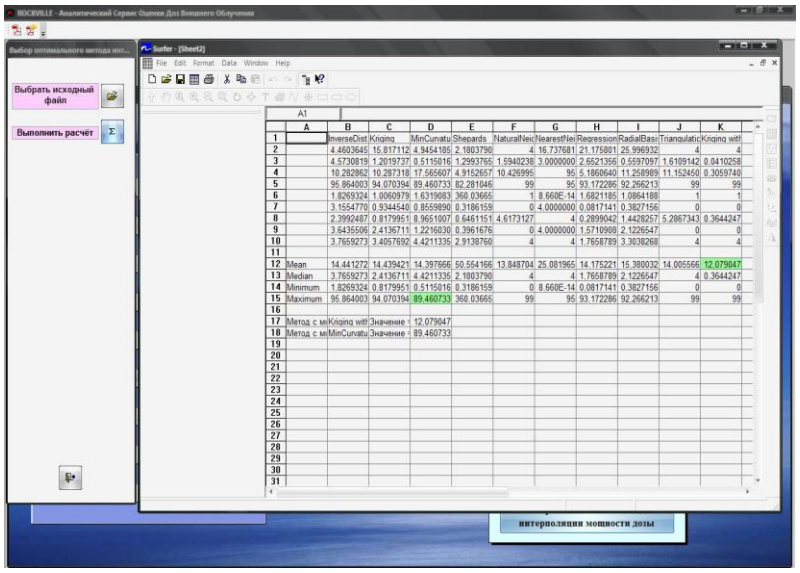

Figure 10. ***Prognosis of Contamination Migration.***

«The Databank Specification» and «User Manual» have also been prepared concerning the databank.

«The Databank Specification» consists of general provisions, the databank functions, the databank frame, classes and tables of the databank and the structure of the databank tables with description of tables included in the databank and types of fields in the tables.

«The User Manual» has been developed to work in autonomous mode using the specialized database management system Access, which is utility of the Microsoft Office standard pack.

The GIS has been developed on the base of the Rockville software. The Rockville software was adapted for graphic presentation of data on the radiation situation and data on individual doses to workers of the SevRAO facility (the DOSEMAP project) to be applied by the regulatory bodies in the course of arrangement of radiation hazardous operations on the SNF and RW management at the STS. Construction of the DATAMAP GIS and the mapping database on the radiation situation and database on individual doses to workers of the SevRAO DOSEMAP on the single program platform of the Rockville system permitted to unify the mapping material and to carry out the information exchange between the databases. All these facts promote better implementation of the regulatory supervision of radiation safety and protection at each stage of the STS remediation.

3.4 References for section 3

1. Research report. Regulatory supervision of the public exposure. Development of criteria and guidance for remediation of radioactively contaminated sites and de-licensing of nuclear facilities. Assessment of radiation exposure to the public during routine and abnormal operation mode of SNF and RW STS at the SevRAO facilities in the course of their operation, decommissioning, remediation and de-licensing. Task 2. Project 2. Cooperation between the FMBA of Russia and Norwegian Radiation Protection Authority. – M, SRC-IBPh, 2005. 43 pp.
2. Determination of ^{137}Cs, ^{90}Sr and ^{60}Co in seawater (of different saltiness) and fresh water. In collection of methods for determination of radioactive contamination of the environmental media. M. 1970. Institute of Biophysics MZ USSR, p.49-53.

3. Final report on findings of radiation measurements on-site the SNF and RW STS at Andreeva Bay, Stage nr.5, contract nr. 104 of 02.09.02, MCEB, 2002.
4. Hygienic requirements for safety and food cost of the foodstuffs //Sanitary and epidemiological rules and regulations. SanPiN 2.3.2.1078-01- M.: FGUP «InterSEN», 2002. - 168 p.
5. Protocols of radiological laboratory of the radiation safety division ZF FGUP «SevRAO» over 2008. – Zaozersk, 2008.
6. Radiation-spectrometry examination of buildings, constructions, samplers of soil and rock ground received during boring at Andreeva Bay. Final report No 16.1253 Ot, FGUP NIKIET, 2004, 85 pp.
7. Radiation safety standards. NRB-99. Hygienic regulation SP 2.6.1.758-99, Minzdrav of Russia, - 1999. – 116 p.

4 Preparing and Conducting Emergency Training on Radiological Protection of Personnel of the Ostrovnoy Branch of SevRAO and the Population of Gremikha Village

During 2005-2007, two projects on "Improvement of medical and radiological aspects of emergency preparedness and response at SevRAO facilities" and "Development of the operational radiological and medical criteria to initiate an emergency plan and apply early protective actions at the SevRAO facilities" were fulfilled by the specialists of the SRC-IBPh in collaboration with the specialists from NRPA. Those projects resulted in an increased level of medical emergency preparedness at the SevRAO facilities at Andreyev Bay.

In order to put into practice the regulatory requirements and recommendations developed within the framework of the collaboration between SRC-IBPh and NRPA, an emergency training exercise at the site of temporary storage of SNF and RAW at Andreyev Bay was conducted in 2006. The main focus was the medical aspects of emergency response – to provide initial medical aid to injured people. From this work, the necessity was recognised to develop operational radiological and medical criteria harmonized with the approaches by IAEA, WHO, etc. in order to initiate an emergency plan at SevRAO facilities and to apply medical and radiological protective actions in the most consistent and comprehensive manner. Criteria for initiation of urgent protective measures in the case of an accident were developed for application at SevRAO facilities within the FMBA-NRPA regulatory cooperation program [1].

It was then logical to continue the improvement of emergency regulation by preparing and conducting emergency training aimed at radiological protection of the public and the personnel at the Ostrovnoy Branch of SevRAO, accounting for new requirements and criteria. The Ostrovnoy Branch of SevRAO was an important and specific object for such training due to geographical features of its location with respect to nearest settlement and territorial agencies of FMBA of Russia.

4.1 Objectives and scope

The primary objective of the Emergency Training project was to prepare and conduct training on decision-making and application of preventive actions for radiological protection of the personnel of the Ostrovnoy Branch of SevRAO and the population of Gremikha.

The project was focused on radiological protection of the personnel and the population at the Ostrovnoy site of temporary storage of SNF and RW and neighbouring areas in case of emergencies during the work on decommission and rehabilitation. The scope of the project implied active participation of sanitary body of FMBA of Russia, territorial agencies of Civil Defense and Emergency Situations, emergency teams and observers (including foreign observers) in emergency training and discussion of its result. International recommendations on emergency procedures, e.g. [2, 3. 4, 5, and 6] were to be considered, and the results of the project were to be presented in mass media and via other public interaction mechanisms.

4.2 Main tasks and activities

The main tasks included the following:

1. Analysis of the current status of emergency preparedness, notification and possibilities for implementation of countermeasures with regard to the public and the personnel at SevRAO facility in Gremikha

- Inspection of the SevRAO facility in Gremikha, RM-120, MSCh-120, the Murmansk TTsMK, and Emercom of Murmansk Oblast in order to assess emergency preparedness of local system to implement preventative actions aimed at radiological protection of the public and the personnel.
- Study and analysis of the experience of exercises and training in France. Participation as observers at the training conducted by the Institut de Radioprotection et de Sûreté Nucléaire.
- Preparation of assessment report for possibilities of Gremikha village to implement preventive actions for radiological protection of the public.

2. Development and improvement of the system of emergency preparedness, including emergency teams and managing bodies
    - Development of a general scheme of training at the Ostrovnoy Branch of SevRAO aimed at conducting exercises on radiological protection of the personnel and the public.
    - Development agreement and approval of the set of documents to provide emergency training.
3. Conducting the emergency training of the bodies of State Sanitary Supervision, local territorial bodies and emergency teams providing preventive actions for the SevRAO personnel and the population of Gremikha village
    - Conducting the emergency training.
    - Analysis of the results of emergency training and preparation of the final information and analytical materials.

4.3 Discussion and recommendations

The detailed project plan discussed with the NRPA at the kick-off meeting in May 2008, was based on solutions justified by the existing system of emergency response of FMBA of Russia and FMBC emergency centre (EMRDC) abilities. The emergency response bodies of State Atomic Energy Corporation "Rosatom", Emercom and Defense Ministry were involved together with FMBA organizations.

When elaborating the project, the principles of development and organization of emergency response, medical and sanitary support and organizational interaction was analysed for FMBA facilities, SevRAO and local emergency response system during an inspection mission to the Murmansk region.

The expert advice and analysis were provided by EMRDC together with experts of Typhoon RPA and IBRAE RAS.

The radiation situation assessment at SevRAO Ostrovnoy branch was conducted via ARSMS of the site and supervised area and the national Unified Federal ARSMS (UFARSMS). In case of a radiation accident, the source terms (release) and radiation situation parameters are assessed by this system as well as data obtained by SevRAO emergency team conducting the radiation survey.

In August 2008, nine participating organizations were visited:

1. Murmansk region administration
2. SevRAO FSUE in Murmansk
3. Managers, services and teams of SevRAO FSUE in Ostrovnoy
4. Local authorities of Ostrovnoy and Gremikha
5. Navy hospital in Ostrovnoy
6. Medical sanitary unit No. 120 of FMBA of Russia
7. Regional management No. 120,Centre for hygiene and epidemiology No. 120 of FMBA of Russia
8. Regional Emercom department (in Murmansk region)
9. Territorial disaster medicine service

The agreement of the above organizations to participate in the training was obtained; possible challenges of organization and logistics were discussed and measures to decrease the failure risks were noted. The emergency response aspects were analyzed having in mind specific features of operation and geographic position of SevRAO Ostrovnoy branch. The organization of protective measures for personnel and the public of Ostrovnoy was studied.

At the same time, the organizational work was conducted in Moscow to prepare multifocal video conference to practice decision making procedure and analytical expert support of urgent protective and medical measures under the active support of Rosatom Corporation. The agreements and involvement were reached with Rosatom, IBRAE RAS, Typhoon RPA, Department on civil defense, emergencies and fire safety (CD, ES and FS) of Murmansk region, Centre for collection and processing of information of Murmansk department of hydro-meteorological service, St.- Petersburg ETC of Rosatom.

Important and effective support in preparation of the training exercise was obtained via the mission to observe French experience of training and exercises. The involvement of Russian observers in the training and the conducted analysis of training materials at St.-Lorraine nuclear power plant near Blois in October 2008, gave the opportunity to compare organizational, methodological and technical aspects as well as the logistics and equipment for the emergency response in Russia and France. The practical experience of French colleagues regarding registration, notification and emergency planning was extremely useful.

Figure 11. ***Discussion of the current status of project work with French colleagues.***

Many qualified experts of FMBC and other organizations mentioned above were involved in the development of the training work plan. Proposals on the training sequence were discussed and its general plan was elaborated.

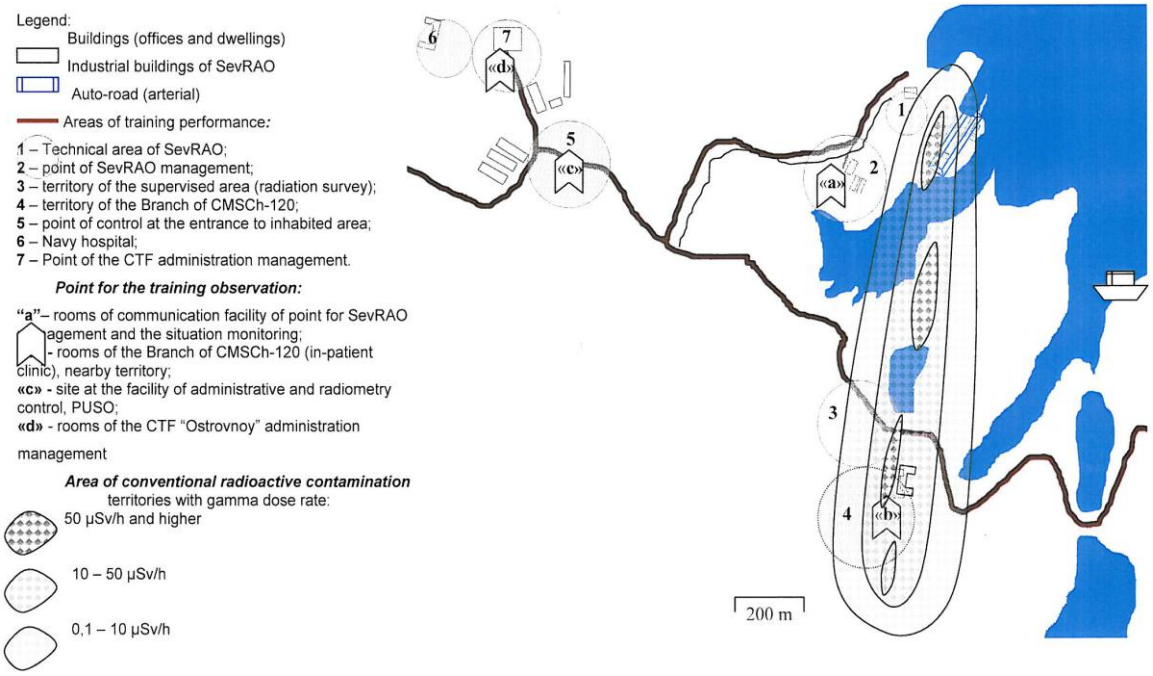

Figure 11. ***Plan of the territory of the emergency training at CTF "Ostrovnoy".***

Challenges and important issues of medical and sanitary provisions in personnel and the public were considered for radiation accidents at SevRAO facilities. Based upon the conducted analysis, recommendations on training procedures for SevRAO facilities were issued. The recommendations were designed to assist the managers of the facility and the region and to be used as training guidelines for SevRAO personnel.

Figure 12. ***Multi-point video conference with all participants.*** *(The first phase - 19 June 2009).*

The major result and practical realization of the project was the radiological emergency training carried out on 19 – 20 June 2009 with personnel of FSUE SevRAO (Ostrovnoy affiliated branch) and Gremikha village residents.

The multiple point video conference was used to practice the decision-making procedure and analytical expertise for urgent countermeasures and medical assistance. Under the notification system in use in Rosatom State Corporation and FMBA of Russia the operative information was exchanged. Information exchanges were arranged between FSUE SevRAO (Ostrovnoy branch and Murmansk headquarters), Department on CD, EC and FS of Murmansk region, the information collecting and processing centre of Murmansk department of hydrometeorological service, St.-Petersburg ETC of

Rosatom, Rosatom SCC, IBRAE of RAS, Typhoon RPA, CMSU No. 120, RM No. 120, CH and E No. 120, and EMRDC of FMBC.

Figure 13. ***Practical actions at Ostrovnoy CTF.*** *(The second phase - 20 June 2009).*

Measures to introduce and implement an action plan to protect personnel were elaborated, radiation safety requirements were fulfilled for emergency recovery operations and issues of urgent medical assistance and transportation of victims to Branch 4 of CMSU No. 120 were solved. Basing upon the radiation survey results and dose prognosis, the provisional evacuation of patients and personnel of Branch 4 of CMSU No. 120 to Gremikha Navy hospital was performed.

The necessary requirements of radiological monitoring, sanitary checkpoint arrangements and additional beds for patients were fulfilled. With the active participation of local authorities, CD services and RM No. 120, the issues of resident notification, sanitary and hygiene, drinking water source protection, and decontamination of roads and vehicles were solved.

The training preparation and progress was observed by Murmansk TV (ARSTVRBC “Murman”) and local TV network of Gremikha. The Rosatom SCC public relations service have arranged the information protection and “information attack” counteraction. The experience of the present training has clearly confirmed the efficiency of the expert support via modern (basically, satellite) communication systems, which needs to be available to medical facilities and teams of FMBA of Russia, which operate in this very region.

Results of the elaborated training have demonstrated that the necessary procedures of radiation hygienic and medical measures implemented for personnel and residents in the early phase of an accident can be provided by manpower of CMSU -120, RM-120 and CH and E -120 (FMBA of Russia) in cooperation with FSUE SevRAO, authorities of Ostrovnoy CTF and the Navy hospital in Ostrovnoy. The availability of recourse to the emergency response system of Rosatom State Corporation, the integration of technical support centers and FMBA emergency centre (EMRDC), the application of modern communication systems for operative radiation situation assessment and expert decisions are of high importance for medical and sanitary support of emergency issues.

The application of European experience for training arrangements and practical support of NRPA promote confidence in effective radiation safety regulation and provisions in Russian Northwest and neighboring countries. A major result of the completed work has been the positive public attitudes regarding sufficient attention attracted to radiation safety issues and perspectives of SevRAO branch operational activities. The consolidation of knowledge and skills in personnel of participating organizations regarding public countermeasures and open demonstration of resources and abilities of the multi-layer system of the emergency response are most effective instruments to reach a positive public attitude.

The training experience and follow up discussions held with radiation safety and emergency response specialists will provide more effective operational interaction among the teams and organizations of FMBA of Russia and Rosatom, when planning and implementing protective measures in case of radiation accidents. Besides, demonstrated abilities of agency systems of the emergency response will provide the ability to use these resources by executive authorities (municipal and regional levels) in case of emergency situations of natural and technological character in Murmansk region. The involvement of foreign observers provided useful feedback on the application of international guidance [2, 3. 4, 5, and 6] and independent evaluation of the sufficiency of existing emergency response systems.

4.4 References for section 4

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2. Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency: EPR-EXERCISE, 2005, IAEA, Vienna.
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5 Safety Improvement through Performance Reliability Monitoring

At the present time, the operator (SevRAO) performs some urgent operations for recovery of SNF and RW at the STS in Andreyev Bay under conditions of degraded containment barriers. In addition, some technological operations connected with the SNF management are being performed (such as unloading containers with the SNF removal from the previous container and its repacking etc.). The radioecological situation at the STS can change following these operations and generally, such change is under control.

Nevertheless, during this work, there is a risk of radiation accidents because of human errors. According to the literature e.g. [1], up to 80% of accidents and incidents registered are due to the personnel errors following incompliance of psychological and psycho-physiological characteristics of a worker as would be required to carry out the activity being performed. The human risk at the STS is currently only under limited control, because there is no established system for psychological and psycho-physiological assurance of the performance reliability of nuclear workers.

Substantial fundamental research has confirmed that analysis of the personnel performance reliability at facilities with potentially hazardous technologies was the most prospective direction to reduce problems concerned with negative demonstrations of the human factor. Accordingly, the background to the PRM project was the need to improve safety through performance reliability monitoring

5.1 Objectives and scope

The primary objective of the PRM project was to improve the radioecological safety through development of techniques for timely identification of workers with a negative prognosis for their performance reliability among those involved in SNF management. The techniques included methodological procedures, equipment for making psychological and psycho-physiological tests, and hardware and software for information management.

The output materials were intended for regulatory authorities, operators and other stakeholders in the Russian Federation, Norway and other states involved and interested in remedial activities in Northwest Russia.

5.2 Main tasks and activities

The main tasks carried out within the project included the following:

1. Development of medical and technical requirements for the expert-and-diagnostic system of risk monitoring of the performance reliability violation of persons involved in operations at STS (EDIS_STS)
    - Identification of occupational specific characteristics of persons involved in SNF management, and methods of their assessment, as well as criteria for identifying individuals with negative prognosis of their performance reliability
    - Identification of medical and technical requirements for EDIS_STS and specification of its hard/software
2. Development of the pilot version of EDIS_STS, including User manual and guide and Application description.

3. Research report including specification of occupational specific merits of persons involved in SNF management operations; medical-and-engineering requirements for the pilot version of the expert diagnostic system of risk monitoring of the performance reliability violation and its specification; proposals on arrangement of organizational engineering system for assurance of the performance reliability of persons involved in the SNF management operations.

5.3 Discussion and recommendations

In recent years, increasing attention has been paid to psycho-physiological examinations performed as an integrated part of medical supervision, because of emergencies at the potentially hazardous facilities in different countries. It is typical that de-adaptation violations have been revealed not only for persons with diagnosed pathology including non-specific psycho-somatic occupational limiting diseases, but also for practically healthy persons. In addition, the mentioned persons require increased attention in terms of risk of potential performance reliability violation.

Therefore, the organizational-and-technical system for the performance assurance (OTSPN) of the SevRAO personnel can be considered as a component of the current system for the medical-psychological (psycho-physiological) support of facilities with potentially hazardous technologies under the supervision of FMBA of Russia. It maintains the professional selection of workers, annual medical and psycho-physiological examinations and, in some cases, pre-shift control for work authorization in terms of medical and psycho-physiological indications.

The probability of an operational error is dependent upon factors such as current medical, psychological and psycho-physiological characteristics of the individual, stable psychological merits of the personality and nature, individual culture level, educational and developmental level, moral endurance, vocational training (qualification and competency), professional and environmental conditions, quality of regulatory and organizational directives and occurrence of pernicious habits.

In order to arrange the OTSPN, some methodical and technical tools have been developed based on technical and scientific references from Russian and from other countries [2 – 15].

1. Occupational specific merits of workers involved in the SNF management have been revealed and structured.

The profession-graphic analysis of workers involved in SNF management has been performed to reveal their occupation specific merits, by expert interview and documentation analysis.

The findings showed that in the course of SNF management, both psycho-physiological and physiological functions of workers become activated. Thus, the extent of responsibility for the inherent failure is rather high. The correction of error can require additional efforts of the whole team. In irregular situations, hazard to a worker's life is not improbable.

According to the hygienic criteria of assessment and classification of work conditions in terms of harm and hazard indexes, accumulative industrial factor and heaviness of the working process, the work of persons involved in SNF management operations can be considered as that requiring permits to work. Examination of SNF management technologies, occupational instructions of workers at the SevRAO facility 1 (Andreyev Bay), and the expert assessment of requirements for workers merits by SevRAO representatives, permit to identify the personal, psycho-physiological and physiological occupational specific merits parameters of workers involved in the SNF management.

2. An algorithm for assessment of the occupational adaptation of workers has been developed.

3. Criteria have been proposed to identify persons with psycho-physiological adaptation violation on the base of medical and psycho-physiological indexes (risk group).

4. Medical and technical requirements have been stated for the EDIT_STS.

These requirements have been formulated in terms of the occupational specific merits of workers and methods of their assessment. The «EDIS_STS» must support implementation of techniques for psychological testing, psycho-physiological testing, physiological testing and expert assessment of the occupational adaptation.

Technical requirements for the "EDIS_STS" include equipment for: carrying out psychological and psycho-physiological examinations; for inspection of the neuro-vegetative system, and for recording the static tremor indexes and tapping-test results.

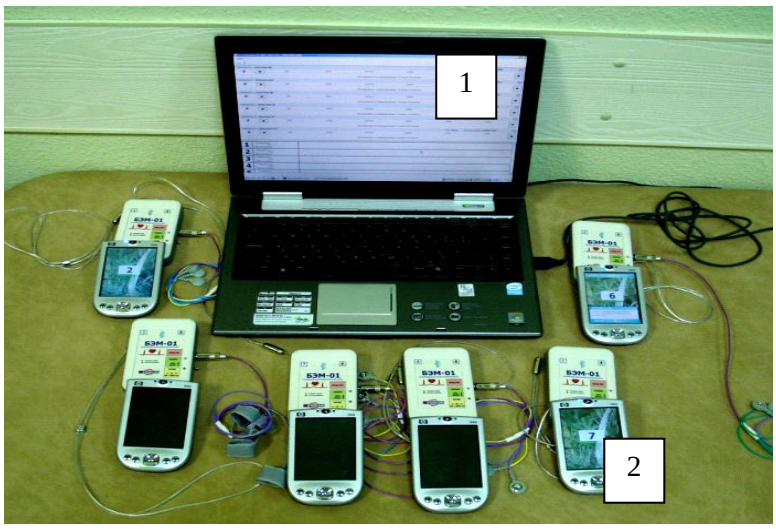

Figure 14. ***Picture of the EDIS_STS pilot version equipment.***

5. The pilot version of the “EDIS_STS” has been developed and transferred to the CMSCh-120 for use during annual medical and psychological (psycho-physiological) examinations of the SevRAO workers.

The “EDIS_STS” pilot version has been developed on the basis of medical and technical requirements and Figure 14 shows the equipment for the pilot version. It consists of the notebook (1), the Personal Digital Assistants (2), and cordless units to record the psycho-physiological characteristic. Connection between all constituents of the “EDIC_STS” is cordless.

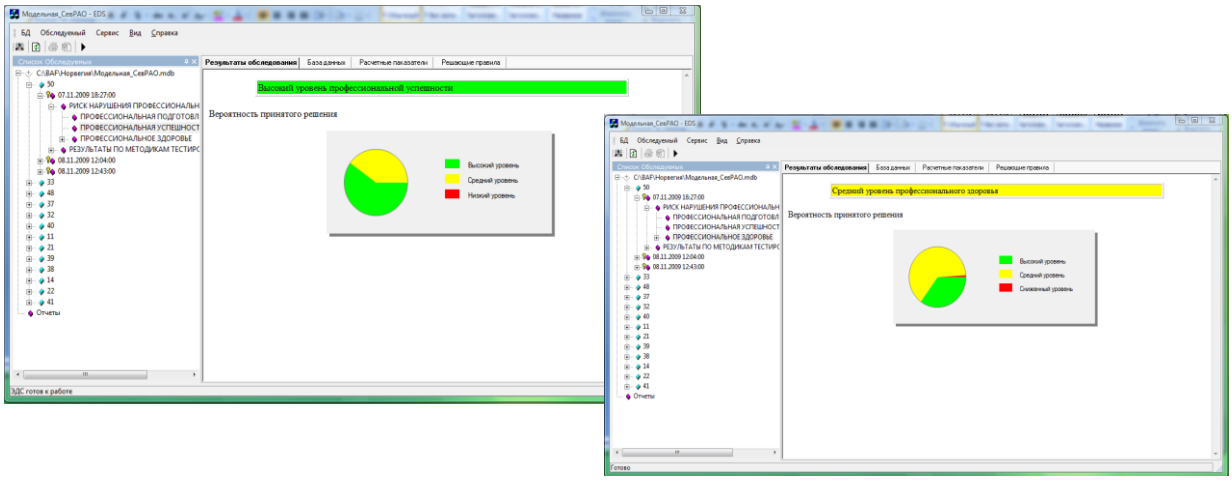

Figure 15. ***Findings of the occupational success and health assessment.***

The EDIS_STS is implemented as a multi-window application developed in compliance with the requirements for the software under up-to-date operation systems of Windows 9x/NT series.

Methodical, hard-software and information tools enclosed in the EDIS_STS are aimed firstly at definition of compliance with the occupational specific merits, levels of psycho-physiological adaptation (PFA) and health of the SevRAO workers with their occupational requirements.

The EDIS_STS practical application will permit the CMSCh-120 to identify more effectively persons with negative predictions among workers requiring the Rostechnadzor permission to carry out operations. As such, the MSCh specialists can work within the single computerized protocol of the medical and psycho-physiological examinations. The plant's sectorial doctor can be able to compare findings of clinical and pre-nozological examinations in real time and, as necessary, prescribe some remedial actions using the basis available at the MSCh.

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6 Requirements for protection of workers, the public and the environment during RW management at the Centre for conditioning and long-term storage

A large amount of RW and SNF has been accumulated in the course of operation of SevRAO facility 1 (STS in Andreyev Bay) and facility 2 (STS in Gremikha) ex-navy shore technical bases. The RW and SNF have not been removed and are being stored on the industrial sites of the mentioned facilities. Now, a strategic plan has been developed relating to both accumulated SNF awaiting transportation for processing, and safe RW storage. In the course of implementing this plan, SNF are planned to be removed for processing at PA "Mayak", while RW generated, as well as RW resulting from dismantlement of nuclear submarines and accumulated on the sites following past activity, are planned to be located for storage in the Centre of conditioning and long-term storage of radioactive wastes at SevRAO facility 3 (CCLS in Saida Bay). The design concepts adopted for the CCLS include features based on facilities in Germany.

This gave rise to the need for development of criteria for technological safety and human protection during conditioning and storage of all types of Low Level Radioactive Waste and Intermediate Level Radioactive Waste.

6.1 Objectives and scope

The project objective was to develop regulatory requirements for occupational, public and environmental protection during arrangement and implementation of RW management at the CCLS. In order to meet this objective, a regulatory guidance has been developed, called "Requirements for technological safety and occupational, public and environmental protection during RW management arrangement at SevRAO facility 3 (Saida Bay)".

The developed guidance was intended for application by: FMBA of Russia supervision bodies, organizations performing the project design and operators of Northwest Russia who plan to convey their RW to the CCLS, as well as institutions involved in RW management during remediation of SevRAO sites.

6.2 Main tasks and activities

The main tasks carried out within the project included the following:

1. Threat assessment during establishment of host-based system to manage RW produced at Northwest facilities:
    - Review of available regulatory documents and acceptability analysis of international and national requirements for radiation safety and protection of workers and the public during RW management for the CCLS special features
    - Qualitative and quantitative analysis of RW generated at facilities of the Northwest region and examination of RW characteristics planned to be accepted for long-term storage
    - Analysis of the design documentation on management of RW planned to be accepted for long-term storage of the CCLS. Development of radiation protection requirements for radiation safety taking into account special features of the CCLS including decommissioning and release of the centre from radiation control.

As a result of this task, the Report "Threat assessment during establishing the host-based system to manage RW produced at the Northwest facilities" was completed and submitted to FMBA and SevRAO/Rosatom.

2. Development of the Guidance "Requirements for radiation protection of workers, the public and the environment during RW management arrangement in the CUS (SevRAO facility 3)", through discussions with experts from the CCLS and NRPA, as well as experience transfer from experts at the German waste facility at Greifswald.

6.3 Discussion and recommendations

The project enabled the development of radiation protection requirements for safe RW management at the stages of their treatment, conditioning and long-term storage at facilities in the CCLS.

In the course of work, the current regulatory documents were reviewed and the suitability of international and national requirements for radiation safety and protection of workers and the public during RW management at the CCLS were analysed. [1 - 18]

The international documents: recommendations; guidelines; rules for different aspects of the RW management, their classification, options of storage and final isolation; release facilities from regulatory control etc. permitted to build effective national legal system and relevant organizational infrastructure in order to assure adequate RW management. But these documents established requirements for radiation protection in terms of objectives much wider than the single area of the RW management.

The completed comparative analysis of the international recommendations and German regulatory documents on safe RW management showed that they could be used in Russia with some modification.

Figure 16. ***Experts from the EWN GmbH Company (Germany), NRPA (Norway) and Burnasyan FMBC (Russia) participated in the international workshop, 9 - 10 September, 2009. Here they look at the EWN GmbH operation of RW management at the storage facility ZLN.***

Application of the German technologies of treatment, conditioning, and long-term storage of intermediate and low level wastes is possible only for planning and layout solutions according to NRB-99, OSPORB-99, SPORO-2002 and SP PUAP-2003. [19, 20, 21 and 39].

Quantitative and qualitative analyses of RW generated at the Northwest region facilities and characterization of waste planned to be accepted by the CCLS have been carried out.

In contrast to the STSs at Andreyev Bay and Gremikha, the CCLS at Saida Bay is being arranged taking into account up-to-date requirements for radiation safety and protection, so radiation threats are relatively small here. Analysis of the RW generated at the facilities of the Northwest Russia involved in handling of sources of ionizing radiation shows that the Saida CCLS must accept about 100 000 m^3 of solid RW with gross activity $3{,}3*10^{16}$ Bq. The RW, which will be generated in the course of treatment of more than 5000 m^3 of liquid RW with gross activity up to $4*10^{14\ Bq}$, accumulated up to now and being generated during radiation hazardous operations at the mentioned facilities should also be added to this amount. These results does not account the solid RW generated at the Kola Nuclear Power Plant.

According to the SevRAO prognosis evaluations, about 83% of solid RW shall be accepted by the Saida CCLS will have activities lower than 10^3 kBq/kg (low level RW), 15,5% - from 10^3 to 10^7 kBq/kg (intermediate level) and 1,5% - more than 10^7 kBq/kg (high level).

The Decommissioning Centre Saida serves the purpose of accumulation and long-term storage of solid and long-lived, low- and intermediate level RW resulting from dismantlement of navy ships, vessels of the FGUP "Atomflot" equipped with nuclear powered installation, their service ships and legacy RW and RW resulting from remediation of the sites of the SNF and RW temporary storage in the Northwest Russia. The RW long-term storage is aimed at reducing their activity naturally up to values permitting, according to the OSPORB-99 [20] requirements, to release them from radiation control.

According to the design, the CCLS consists of: the production-laboratory unit, the workshop for conditioning with divisions and adjacent storage facility subdivided into the sections for low-level RW, intermediate-level RW, flammable RW and bulky RW. In addition, a workshop for disassembling of three-unit and single-unit reactor compartments is planned to be constructed.

Dismantlement, decontamination, conditioning and temporary storage of bulky components, including compartments of decomissed nuclear vessels and/or radioactively contaminated ships and other radioactive waste are all planned to be implemented at the CCLS.

Figure 17. ***The workshop at the SevRAO facility 3 (Saida) on sanitary and epidemiological supervision, held on 16 June, 2009 with participants from the NRPA, FMBC, SevRAO, CKDH RAO Saida (SevRAO facility) and RM- 120.***

It should be noted that, in the course of operations, the workers involved in RW treatment and storage will be exposed to combined external and internal radiation. According to the Russian norms SPORO-2002 par.5.8 [21] and OSPORB-99 par. 3.5.16 [20], each CCLS room, including the storage facility, must be designed and built taking into account requirements for workshops suitable for at least class II operations. Workshops, where the intermediate-level RW is sorted and the concentrate after evaporation of the decontamination water is handled, must be designed and built taking into account requirements for workshops suitable for class I operations.

A set of radiation facilities allocated on-site belong to the class III category by its potential radiation hazard. Radiation facilities of the class III category must have the health protection zone calculated

according to the SP 2.6.1.2216 – 07 [22]. The Health Protection Zone (HPZ) dimensions may be limited by the site area. Given that, the facility must be designed in such a manner that radiation exposure during an accident is restricted by the HPZ and the possibility for public exposure is close to.

The RW amount and gross activity planned to be treated and long-term stored and radiation protection system being designed within the must not lead to increased potential hazard of the facility as a whole – SevRAO facility 3.

To carry out radiation monitoring, the design envisage engineering tools supporting:

- dose rate monitoring in the main workshops;
- radioactive aerosol control in the main workshops;
- control of activity measurement in the material flow;
- activity control and identification of radionuclides in the waste water after decontamination;
- monitoring of radioactive contamination of the skin and clothes of personneland surfaces of the equipment and workshops;
- monitoring of individual external doses.

The radiation monitoring system of this design is automated to perform permanent monitoring of the radiation situation, systems of the stationary engineering tools and portable devices. At the CCLS, radiation monitoring will be performed under normal conditions of routine operation and under conditions of routine operation violation, including emergencies. Having in mind that in the course of conditioning, dismantlement will produce large amounts of radioactive aerosols, the radiation monitoring system must include a procedure of radionuclide intake evaluation, using whole body counters (WBC) or excreta monitoring.

The CCLS is aimed at reducing radiation risk at facilities of the Northwest Russia. At the same time, it will promote reduction of radiation loads at 8-10 RW producing facilities due to the RW removal to the CCLS treatment. As a radiation hazardous facility, it is being designed and constructed taking into account all up-to-date international recommendations and Russian legislative and regulatory documents on safe RW management.

Generally, the radiation safety system proposed by the German side promotes radiation protection of workers, the public and the environment during construction and for the whole period of its operation, but some key issues of RW management requires particular focus within the special regulatory documents.

In order to implement effective sanitary and epidemiological supervision of safe RW management at the CKDH RAO, the Guidance “Requirements for Protection of Workers, the Public and the Environment during Arrangement of Radioactive Waste Management in the Centre for Conditioning and Long-Term Storage at the Federal State Unitary Enterprise, Northern Federal Facility for Radioactive waste Management” has been developed (see Appendix 1).

This document takes into account the special features of RW management in Northwest Russia, resulting from implementation of programmess aimed at nuclear legacy mitigation. It specifies the RW management procedure during their long-term storage; regulates the safety requirements at different stages of the RW preparation for their long-term storage, including gathering and sorting in compliance with the established procedure for classification, package, transportation, treatment, conditioning and storage.

6.4 References for section 6

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30. Federal Target Program «Nuclear and Radiation Safety of Russia».

31. Federal Target Program «Mitigation of Radiation Accident Consequences for the Period up to 2010».

32. Health Protection Zones and Supervised Areas of the Radiation Facilities, Operational Conditions and Justification of Borders (GN 2.6.1.19-02). M.Minzdrav of Russia, 2002 –p.13. Approved by the RF State Chief Medical Officer G G Onishchenko, 2002.

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7 Additional Activities

7.1 Workshop on "Application of Radioecology to Regulation of Nuclear Legacy Management"

Management of nuclear legacy requires good cooperation among a wide range of stakeholders. The workshop **"Application of Radioecology to Regulation of Nuclear Legacy Management",** held 14 – 15 June 2008, in Bergen, Norway, was intended to promote cooperation among regulatory authorities and their technical support organisations, and to investigate the challenges in the application of good science within the regulatory process for nuclear legacy management.

There were over 60 representatives of regulatory authorities and technical support organisations from 8 countries as well as representatives from the International Commission on Radiological Protection, the International Atomic Energy Agency and NATO. Regulatory cooperation is a major part of the Norwegian Plan of Action to improve nuclear and radiation safety in Northwest Russia. For operational safety, and day to day site management, radiation monitoring can be used directly to confirm compliance with standards. By contrast, for long-term legacy management, it is necessary to rely on measurements combined with assessment models. Together, these allow prospective assessments of alternative options for site management, or to plan responses to possible future accidents. There are many difficulties relating to interpretation of radioecological data within the context of specific eco-systems, and they are coupled with engineered features of sites and facilities.

The NRPA has had considerable experience working with Russian colleagues at sites in Northwest Russia and have made good progress. However, some interesting questions were raised at the workshop, including:

- How do we interpret the measurements for use in the assessments, taking into account the uncertainties?
- Can we learn from the waste repository community, which has been studying the longer term for many years?
- Can we develop a common and documented understanding of the priority issues which deserve further attention to resolve uncertainties?
- Can we do more to share existing information?
- Should there be a wider regulator's forum on nuclear legacy management?

There was a wide range of presentations made at the workshop addressing these questions and offering different perspectives from different countries. These prompted substantial discussion and the following points of consensus emerged:

- Regulatory decisions should be supported by science. However, there are significant uncertainties in scientific information relating to management of emergencies, routine present day situations and long-term site management and waste disposal, all of which are relevant to nuclear legacy management.
- These uncertainties relate to different radionuclides and on different temporal and spatial scales. There is no single solution, but a broad range of scientific and other factors to address.
- Problems associated with large possible impacts, which affect the progress of strategic plans and which absorb large resources are clearly more important than those which do not.

To address these issues it was recommended that regulators should:

- Maintain an understanding of the operational strategy;
- Make Regulatory Threat Assessments for components of that strategy;
- Maintain regulatory development to provide:
    - adequate and relevant norms and guidance,

- an efficient regulatory review process, and
- compliance monitoring;

- Maintain an independent Environmental Impact and Risk Assessment capability; and
- Be aware of the weaknesses in those assessments and include uncertainty estimates.

Uncertainties can be managed most efficiently through a tiered approach to assessments, as follows:

Tier 1. This involves simple models with limited data requirements and robust, conservative assumptions. This is not resource intensive. If the results suggest that the impacts meet regulator and other requirements, then this is a sufficient level of assessment.
Tier 2. If Tier 1 assessment raises some concerns, then closer inspection of the local situation: source, pathway receptor etc., may be called for. More data is required to support more detailed process orientated, dynamic models.
Tier 3. If Tier 2 still raises concerns then site specific measurements and experiments to support the a third Tier of assessments may be necessary, including where appropriate, development of new models. The specific research needs will be identified by uncertainty analysis component of the Tier 2 assessments.

This approach, combined with initial Threat Assessments, helps to ensure that the research resources are applied to problems which impact most heavily on people and the environment.

Specifically challenging issues identified included:

Responsibility: Regulatory bodies should contribute to their national strategy for legacy management and take account of all the steps in the wider radioactive waste management strategy. Regulations and regulatory responsibility must be clear to remove uncertainties in the process of supervision.

Knowledge Management: We should learn from past events, and maintain records not just for immediate events management but also for the future, and make use of the memory of older or retired staff.

Uncertainties: Knowledge of important uncertainties comes from properly implemented safety assessments. If these assessments have not been done, this becomes the first priority.

Training: We should provide training courses for younger persons to develop the necessary skills. Competence levels in radio-ecology and other assessment skills need to match needs for managing the legacy, but also to support new developments in nuclear power and other uses of radioactive material.

Regulatory Functions: We should improve the integration of regulatory branches, to support application of the optimization principle and achieve a balanced approach.

Data Resources and Management: We should:

- Make data acquisition and interpretation an integral part of environmental impact and risk assessments.
- Make wider use of data resources at the IAEA and other organizations, such as the International Union of Radioecology, and provide our own experiences and inputs to such international initiatives.

Coordinated Research: Some of the challenges are very fundamental and very complex, e.g. multi-stressors. The funding for resolving such issues needs combined funding systems, to produce core competence.

Communication: Better communication strategies are needed to explain: international recommendations, the national policy in each country, the strategy to deliver the policy, what the

safety standards mean, and how regulatory supervision is applied to ensure the standards are met. Risks and uncertainties identified by the assessment process need to be better communicated to risk managers and other non-specialist stakeholders.

Sharing Experience: There is a need for improved mechanisms for sharing experience on: data acquisition, site generic data, assessment methods, regulatory processes such as licensing and compliance monitoring, communication etc., for legacy site management. Exchange of information among research groups and with regulators is to be encouraged.

7.2 Presentations at conferences

Participants of the Projects have made several presentations on the topics of collaborative investigations at different conferences. In particular:

At the 12th International Radiation Protection Association Conference, Buenos Aires, October 2008.

- Practical Application of the International Safety Regime in NW Russia: Experience from the Norwegian Plan of Action. Sneve M K, Kiselev M, Kochetko O, Shandala N and Smith G.
- Radioecological condition assessment and remediation criteria for sites of spent fuel and radioactive waste storage in the Russian Northwest. Shandala N, Kiselev M, Sneve M, Tito A, Smith G Novikova N and Romanov V.

At 'Environmental Health Risk V' Wessex Institute of Technology conference, 21-23 September 2009, New Forest, UK:

- Environmental radiation monitoring at the areas of the spent nuclear fuel and radioactive waste storage in the Russian Northwest – N Shandala, S Kiselev, M Sneve, V Seregin, E Shchelkanova and G Smith
- Environmental remediation of nuclear legacy sites in the Russian Northwest: regulatory approach - N Shandala, V Seregin, M Sneve, S. Kiselev, A Kosnikov, and G Smith

At 54th Annual Symposium of Health Physics Society, 12-17 July 2009, Minneapolis, USA:

- Independent regulatory study of radiation situation nearby SNF and RW sites of temporary storage in the Northwest Russia – N Shandala, D Isaev, M Sneve ea
- Radio-ecological criteria and regulations for remediation of the navy shore infrastructural facilities – N Shandala, V Seregin, M Sneve

At 1st International Rosatom workshop on Decommissioning of nuclear energy using facilities: Conceptual aspects and practical experience, 2-5 June 2009, - Moscow, Russia, Organizers: Rosatom, Atomstroj, VNIPIET, NIKIET:

- Radiation safety regulation during decommissioning nuclear energy using facilities: review of Russian and international criteria – N Shandala, M Balonov, M Sneve, V Romanov, M Semenova, and G Smith

At International Conference on Effective Nuclear Regulatory Systems, IAEA, 14 – 18 December 2009, Cape Town:

- Integration of Safety Supervision across Different Types of Legacy Sites Accounting for All Stages in Site Remediation – M K Sneve

7.3 Papers in scientific journals

The findings of collaborative FMBC-NRPA investigations found their reflection in a series of four articles in the Journal of Radiological Protection, Volume 28, No 4, December 2008:

- Regulatory supervision of sites for spent fuel and radioactive waste storage in the Russian Northwest – Shandala N K, Sneve M K, Smith G M, Kiselev M F, Kochetkov O A, Savkin M

N, Simakov A V, Novikova N Ya, Titov A V, Romanov V V, Seregin V A,. Filonova A V and Semenova M P

- Radiological protection regulation during spent nuclear fuel and radioactive waste management in the Western Branch of FSUE 'SevRAO' – Simakov A V, Sneve M K, Abramov Yu V, Kochetkov O A, Smith G M, Tsovianov A G and Romanov V V
- Radiological criteria for the remediation of sites for spent fuel and radioactive waste storage in the Russian Northwest – Shandala N K, Sneve M K, Titov A V, Smith G M, Novikova N Ya, Romanov V V and Seregin V A
- Medical and radiological aspects of emergency preparedness and response at SevRAO facilities – M.N. Savkin, M.K. Sneve, M.I. Grachev, G.P. Frolov, S.M. Shinkarev and A. Jaworska

One more article - Regulatory supervision of the SNF and RW sites of temporary storage (N Shandala, V Seregin, M Sneve) – was published in Environmental Safety N 3, 2009, p 46-53

8 Discussion and Overall Conclusions

During 2008-2009, a geo-informational system was developed under the DATAMAP project for the purpose of technical support during the regulatory supervision of the STS remediation. As a result, the computer system has been developed to facilitate visualization of the radiation measurements on the STS site, to interpolate the obtained data over the full STS area, to estimate the interpolation error, to specify the sufficiency of data and to identify areas for additional measurements implementation. Moreover, the system provides a function of data comparison and visualization with the criteria established in the Guidance R 2.6.1. 25 - 07 «Criteria and norms for remediation of sites and facilities contaminated with man-made radionuclides, FGUP «SevRAO». The system may now be tested at the restricted part of the STS area, where remediation is now in progress intensively.

An emergency training exercise on radiological protection of the personnel from the SevRAO facility "Ostrovnoy" and the population of Gremikha village was conducted in June 2009 with support of the Norwegian Radiation Protection Authority. This demonstrated the effectiveness of the emergency response system under the FMBA of Russia and communication between the response organizations under the State Atomic Energy Corporation "Rosatom" in case of a radiation accident. An important result of the training was an opportunity to inform the public about the efforts of the operator and regulator aimed at radiation protection and sufficient preparedness and resources for the emergency mitigation in the region. It was also a very useful exercise because of the involvement of the many agencies involved in emergency preparedness and response. It was noted that remote places with weak transportation options like Gremikha represent special challenges regarding the improvement of medical qualification of personnel and system of analytical expertise, but these can be addressed by using modern communication tools and operation of emergency centers of FMBA.

A software for the mapping database of the radiation situation parameters at SevRAO facilities has been developed, and a draft version of its specification has been made under the DOSEMAP project. Moreover, a computer scheme of workshops in new Complex facilities for the SNF and RW management, the design of which is already available, has been developed. A software for the database on individual doses to the SevRAO workers has also been developed, and a draft version of its specification has been made. The "Doses" database provides input and editing of data on exposure to workers according to the card of individual dose account and also search for, output and print of necessary data at user request. The database allows precise time control of the effective and equivalent dose accumulation and calculation of permitted dose on a shift by shift basis to perform radiation hazardous operations. Two draft guidance documents have been prepared: «Application of the database of the radiation situation parameters and database of individual doses to workers for arrangement and performance of radiation hazardous operations» and «Application of the database of the radiation situation parameters and database of individual doses to workers to regulate radiation protection of workers»

In order to implement effective sanitary and epidemiological supervision of safe RW management in Northwest Russia, the Guidance «Requirements for Protection of Workers, the Public and the Environment during Arrangement of Radioactive Waste Management in the Centre for Conditioning and Long-Term Storage at the Federal State Unitary Enterprise "Northern Federal Facility for Radioactive waste Management"» (R CKDH RAO - 09)» has been developed. The regulatory document developed takes into account the special features of waste management in Northwest Russia, resulting from implementation of programmes aimed at nuclear legacy mitigation. This document specifies the RW management procedure during their long-term storage; regulates the safety requirements at different stages of the RW preparation for their long-term storage, including gathering and sorting in compliance with the established procedures for classification, package, transportation, treatment, conditioning and storage.

Under the Performance Reliability Monitoring project, the pilot version of the expert-and-diagnostic information system for risk monitoring of the performance reliability violation of workers involved in

the SNF management ("EDIS_STS") has been developed. It is designed to support identification of workers with potentially weak performance reliability. Using the developed methods, and the hardware and software systems for monitoring and analysis, specialists can work within the protocol of the medical and psycho-physiological examinations, to compare findings of clinical and pre-nozological examinations in real time and, as necessary, prescribe remedial actions.

Progress in these projects has been substantially enhanced through interaction with experts and regulatory authorities in other countries, as well as close links with operators, both in Russia and elsewhere. The next stage of the regulatory cooperation programme, described in the next section, is expected to be supported by continued engagement with these and other stakeholders, notably the Contact Expert Group organised through the IAEA and the new IAEA International Working Forum for Regulatory Supervision of Legacy Sites.

9 Future Objectives and Projects

Technical progress in preparation for major remediation projects at sites and facilities in Northwest Russia has been substantial and the necessary regulatory development has paralleled that progress. The next steps therefore focus on practical application of the enhanced regulatory process as the most important SNF and RW operations and site remediation activities are put into practice.

The objectives of the NRPA's continuing regulatory cooperation program, within the context of the Norwegian Plan of Action, is to ensure that remedial activity in Northwest Russia is carried out consistently within the Russian Federation regulatory framework, taking into account international guidance and recommendations, as well as good regulatory practice from other countries, in so far as they are relevant to the Russian Federation. Furthermore, such regulatory supervision should be carried out efficiently, to assist the timely and effective implementation of industrial projects and promote a developing and enhanced safety culture.

The following projects have been initiated to support these objectives.

9.1 DOSEMAP2: Practical adaptation of the Mapping and Doses Databases by radiation protection authorities

The main tasks include:

1. Practical and methodical support of operations at the SevRAO to put the factual materials in the Databases

2. Practical and methodical support of the Database operation in Regional Management Nr 120 (RM-120) under the FMBA of Russia, at the SevRAO facilities 1 and 2. Agreement of the methodical documents for the radiation safety regulation bodies and the SevRAO

3. Approval of the methodical documents for the radiation safety regulatory bodies and the SevRAO. Development of the draft regulatory guidance document "Control of radiation protection of workers during the SNF and RW management".

9.2 DATAMAP-GIS: Implementation of the geo-information system

The focus of this project is scientific and engineering support to the application of the DATAMAP GIS. Improvement of regulatory supervision of the radiation situation at the STS through the software optimization

The main tasks:

1. Transfer of software to SevRAO, holding of a seminar for users and further environmental sampling in the STS area

2. Analysis of the radio-ecological situation at the Andreyev Bay STS over 2010, gathering of comments and proposals from the GIS users.

3. Implementation of GIS amendments and improvements, elimination disadvantages according to the user feedback.

9.3 PRM2: Practical monitoring or performance reliability and development of regulatory processes for monitoring of safety culture

While safety culture development is recognized internationally as very important, the regulatory basis for supporting safety culture is relatively weak. As highlighted by the chairman of US Nuclear regulatory commission, G Jaczko, in his keynote speech to the Health Physics Society 2010 annual meeting, there is a need to recognise:

- the problem of complacency as technology becomes more reliable;
- the significance of human reliability in maintaining safety and security, since human factors/failures, are the most significant cause of accidents;
- the role of safety culture development in reducing human failures.

On the last point he noted the need to be able to monitor for degradations in performance, but that in order to do this, there is a need to development a common understanding of safety culture; a better definition; and embodiment in regulation. The PRM2 project plan anticipated these observations and the main tasks include:

1. Improvement of the software and information tools for performance reliability monitoring of workers involved in the SNF management

2. Development of the methodic documents on assurance of performance reliability of workers involved in the SNF management

3. Development of proposals on assessment of radiation safety culture at the SevRAO facility

4. Development of the method for the radiation safety culture evaluation at the SevRAO facilities

5. Development of the software for evaluation of the radiation safety culture at the SevRAO facilities

9.4 Internal exposure

The focus of this project is WBC calibration and algorithm development to control internal exposure to the SevRAO workers involved in the SNF and RW management in irregular situations.

The main tasks:

1. Analysis of radionuclide composition relevant during SNF and RW management operations, leading to the possibility of radionuclide incorporation into the body, taking account of inhalation, ingestion and skin absorption, as well as via injuries.

2. Development of methods for radionuclide body content measurements for the identified radionuclides. Calibration of the SevRAO WBC installation using the Livermore phantom and voxel phantoms for each radionuclide, as well as the method adaptation for the equipment enclosed in the state measurers inventory, and implementation of their metrological certification according to the requirements of the Russian standard (GOST R 8.563-96).

3. Development of innovative approach for arrangement of the expert system for assessment of individual internal dose based on solving of the inverse problem of the individual measurements interpretation taking into account their uncertainties. Development of methods for internal dose calculation for each radionuclide from the established listing taking into account uncertainties due to the calculation errors.

4. Development of algorithm for examination of workers during the SNF and RW management to evaluate any radionuclide intake, its distribution by organs, dynamics of its excretion, and assessment of doses to whole body and some organs.

5. Clarification (after measurements using the WBC installation) of real intakes of alpha emitting radionuclides and the associated committed internal doses in the irregular situation, including the

express method for the content determination of uranium and sum of transuranium elements in terms of measurement of gross alpha activity in urine.

9.5 Emergency preparedness practice

The objective here is the exchange of the experience and harmonization of expert group approaches when elaborating emergency assessments and recommendations on medical and protective measures in case of radiation events.

The main tasks include:

1. Examination of practice to support emergency preparedness of regional bodies of FMBA for radiation incidents with transportation and international experience in this area.

2. Development of methodological and organizational basics for the interaction of working groups of regulators and supporting experts.

3. Implementation of practical measures to practice the interaction and training of emergency services of operators, regulators and expert groups

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StrålevernRapport 2011:1
Virksomhetsplan 2011

StrålevernRapport 2011:2
Måling av naturlig ultrafiolett stråling i Norge

StrålevernRapport 2011:3
Radioecological consequences after a hypothetical accident with release into the marine environment involving a Russian nuclear submarine in the Barents Sea

StrålevernRapport 2011:4
Radioactivity in the Marine Environment 2008 and 2009

StrålevernRapport 2011:5
Threat Assessment Report – Regulatory Aspects of the Remediation and Rehabilitation of Nuclear Legacy in Kazakhstan, Kyrgyzstan and Tajikistan

StrålevernRapport 2011:6
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StrålevernRapport 2011:7
Progress Report on the Regulatory Cooperation Program between the Norwegian Radiation Protection Authority and the Federal Medical Biological Agency of Russia

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