Environmental Monitoring and Development of Radioecological Criteria and Norms during Remediation of the RW and SNF Temporary Storage Sites in Russia - 11520

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ABSTRACT

Remediation of sites of temporary storage (STS) of spent nuclear fuel (SNF) and radioactive waste (RW) in Russian Fareast and Northwest regions is one of regulatory functions of the Federal medical biological agency (FMBA of Russia). The prime task is to develop radiation environmental regulations on justification of radiation safety assurance during remedial operations at the STS The work has involved the Russian Federation Burnasyan Federal Medical Biophysical Centre, which is technical support organization of the FMBA of Russia [1]. To obtain comprehensive information with respect to current radiation circumstances at STSs with regulatory purposes, radiation-hygienic monitoring of STS facility has been carried out. The Environmental radiation monitoring findings served as a basis for the associated databank arrangement. In thus work took part the Norwegian Radiation Protection Authority (NRPA) in frame of the Norwegian government's Plan of Action to improve radiation and nuclear safety in northwest Russia.

Keywords: remediation, sites for temporary storage, spent nuclear fuel, radioactive waste.

INTRODUCTION

In 1960s, in the Northwest and Far East regions of Russia the technical bases of the Navy Fleet were built to maintain nuclear submarines by performing reloading of nuclear fuel, receiving and storing RW and (SNF). In the light of the operation life termination of the Navy nuclear submarines and their technical service vessels, and because of international obligations of the Russian Federation to reduce armaments, the intensive decommissioning has started since the latter 1980-s. The decommissioning rate was higher than these submarine dismantlement rate limited by the available abilities of the industrial infrastructure. Therefore, radioactive wastes were accumulated at the STS's of the RW and SNF, like a shot. From this perspective, ex-Navy shore technical bases located in Murmansk region (Andreeva Bay and Gremikha village) and at the Primorsk Territory (Sysoeva Bay) are the subjects of the highest attention. In 2000, SEVRAO enterprise in the northwest of Russia and DalRAO enterprise in the Far East were set up for the purposes of environmental remediation of the nuclear legacy sites (fig.1). SEVRAO enterprise consists of three divisions: 1) the site of temporary storage (STS) of SNF and RW in Andreeva Bay, 2) the STS in Gremikha village, where SNF is to be removed and RW management is to be performed, 3) the site for RW long-term storage in Saida Bay. There are three divisions of DALRAO enterprise operating in the Far East region: the first one includes STS in Sysoeva Bay, RW long-term storage in Razbojnik Bay in Primorski Krai, and the STS in Krasheninnikova Bay in Kamchatka. The STS facilities in Sysoeva Bay unlike other STSs (including those located on the Kola Peninsula), continue to accept and treat the RW and SNF.

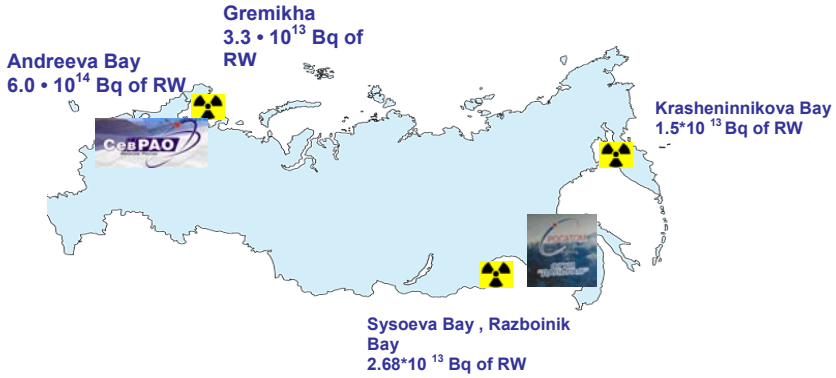


Fig.1 Sites of temporary storage of SNF and RW in Russian Federation

REGULATORY FRAMEWORK

The RW management strategy is the key issue connected with nuclear legacy site. The development of approach to take into account all aspects of the legacy waste management from cradle to the grave is very important. This would explain the key features of interim storage, waste treatment, transport and final disposal. The RW management must be arranged in such manner to confirm that appropriate steps are taken to minimize waste arising and so that an appropriate balance is achieved between worker, public and environmental protection and between control of effluents and routine discharges, risks of unplanned releases from operational facilities and long term risks associated with the RW disposal. Regulation during the RW and SNF management at the Andreeva Bay STS is continuous process, which the FMBA of Russia implements in close cooperation with other Russian responsible authorities [2] (fig. 2). FMBC-FMBA primary tasks and interaction with SevRAO and DalRAO operators, which are under the State Corporation "Rosatom" jurisdiction, are demonstrated here. As is known the operator is fully responsible for radiation protection and safety at the facilities during the RW and SNF management. Being regulators FMBA are responsible for independent control and supervision.

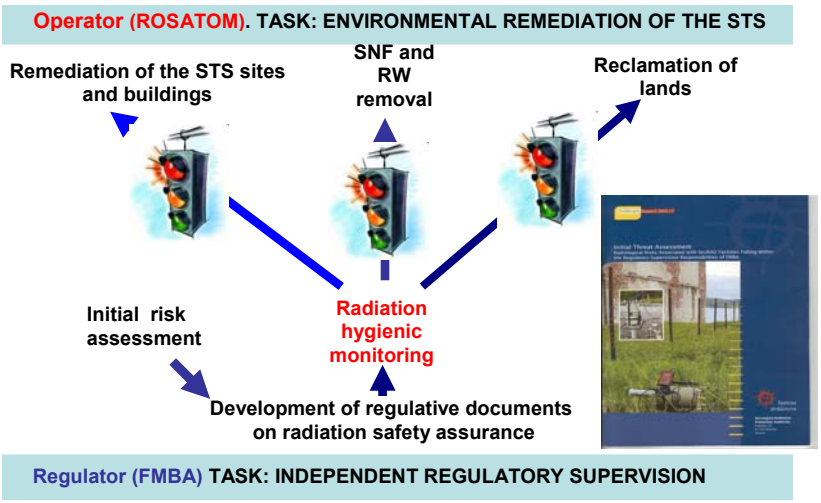


Fig.2 Organization of Independent Regulatory Supervision of the STS Facility

The regulatory framework is realized according the following strategy :

- Independent detailed analysis of the radiation situation at and near the STSs.
- Radiological threat assessment to determine priority issues for regulatory attention.
- Radiological control and monitoring of the environmental conditions.
- Development of a regulatory documentation system ensuring radiation protection observance of workers and the public, including radiation-hygienic criteria and standards of rehabilitation of contaminated territories.

This process is specified by full account of the international recommendations and national experience in the nuclear legacy regulation **[3].**

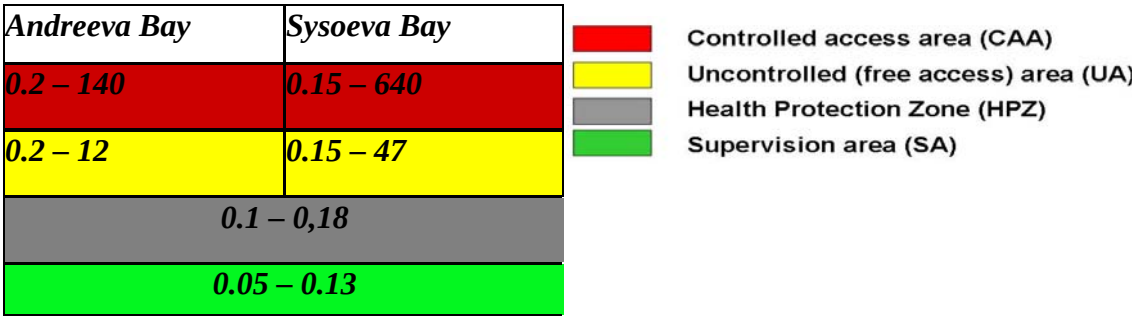
ANALYSIS OF THE RADIATION SITUATION AT THE STSs.

To obtain comprehensive information with respect to current radiation circumstances at STS (independent from regulatory point of view), radiation-hygienic monitoring of STS facilities has been carried out. It included dynamic observation both of the radiation-and hygienic situation parameters and doses to the public living close to the radiation hazardous facilities - STS in Murmansk region and Primorsk Territory. During the expedition travels, samples of environmental media, local foodstuffs and drinking water have been collected. Radiochemical analysis

and γ-spectrometry methods were used in the sample examination. The nature and peculiarity of the STS area radioactive contamination on the Kola Peninsula and in the Far East are the following: 1) high levels of radioactive contamination on the industrial site; 2) non-uniformity of the contamination distribution; 3) spread of contamination in the area of health protection zone. The following environmental components are contaminated: soil, vegetation, bottom sediments and seaweeds at the offshore seawaters. The dominant radionuclides are Cs-137 and Sr-90.

GAMMA DOSE RATES

In the singled out areas gamma dose rate distribution in-situ varies widely. Within the controlled access zone it varies from 0.2 to 500 μSv·h^{-1}. Maximum dose rate values in Sysoeva Bay are 4 times higher than in Andreeva Bay. In the health protection zone (HPZ) gamma dose rate is 0.1-30 μSv·h^{-1}. At the supervised area (SA), gamma dose rate does not differ from the levels typical of the areas of the North West and Far East of Russia.



SOIL CONTAMINATION

Maximum levels of the soil radioactive contamination caused by man-made radionuclides are registered around some emergency facilities for the SNF and RW storage, where the Cs-137 specific activity reaches 6 10^{7} Bq·kg-1, and Sr-90 – 6 10^{6} Bq·kg-1.

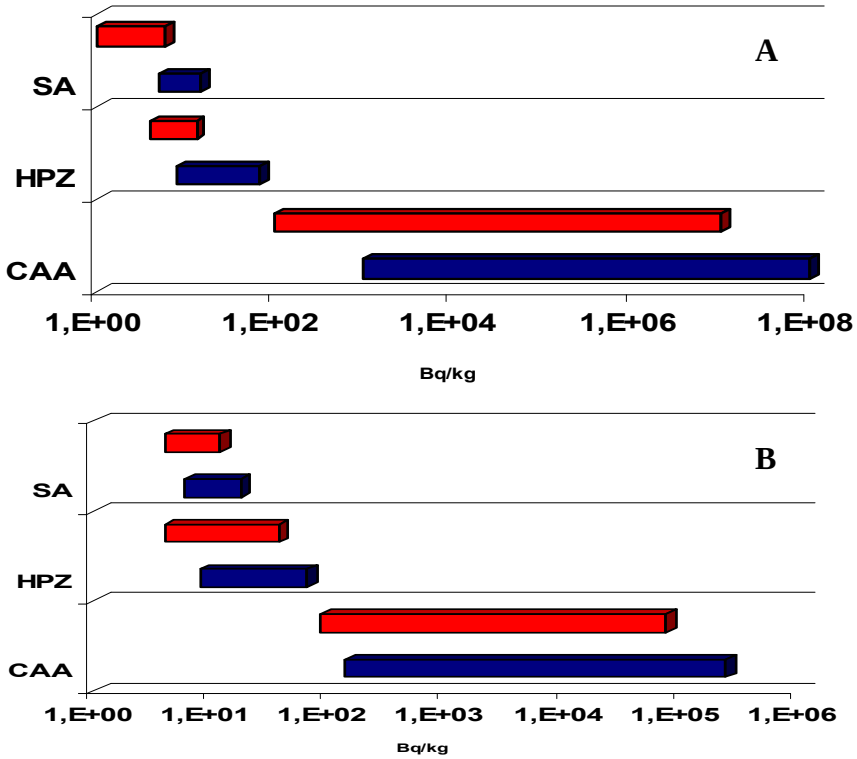


Fig.4 Soil contamination with man-made radionuclides ^{90}Sr & ^{137}Cs (A) Andreeva Bay (B) Sysoeva Bay

In the soil of the industrial sites, Co-60, Eu-152, and Eu-154 are also present in small concentrations. The Cs-137 and Sr-90 concentrations in soil of the HPZ and SA are at the background level typical for «clean» areas of the Russian North and do not exceed 36 and 4 $Bq \cdot kg^{-1}$, respectively.

ENVIRONMENTAL MEDIA CONTAMINATION

In the diagrams (fig.5) (the first – Andreeva Bay, the second – Sysoeva Bay), the green curve shows the average background value of radionuclides in a concrete environmental component. As is seen significant excess of typical background values of Cs-137 and Sr-90 in seaweeds, bottom sediments and in vegetation is observed in some parts of the coastal strip in the health protection zone. In the observation zone it was also registered that in some cases radionuclide values exceeded the background values in the environmental components.

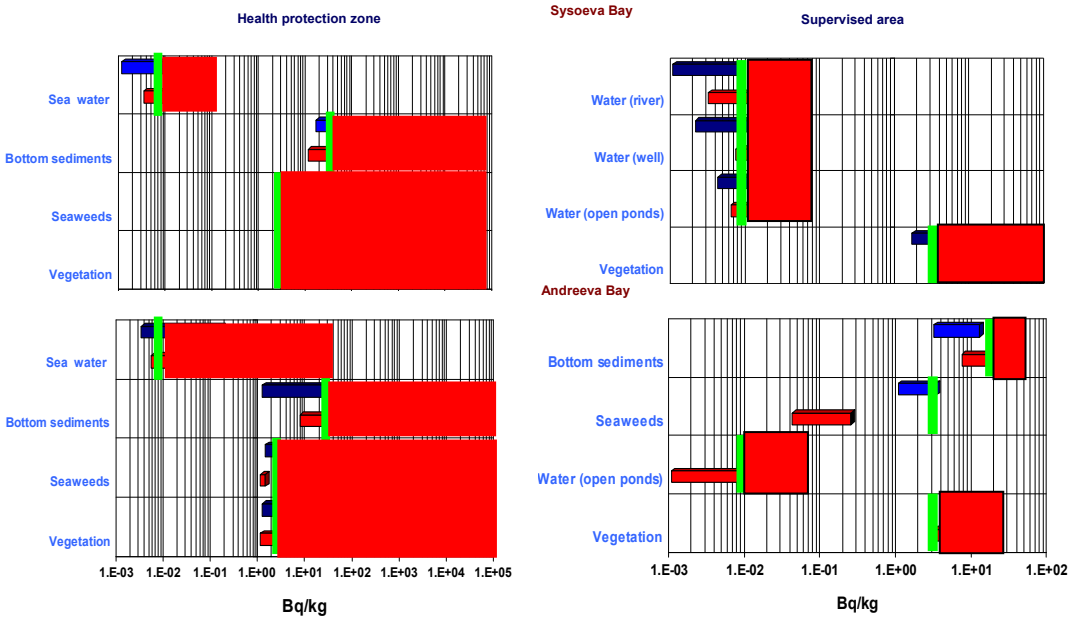


Fig.5 Environmental media contamination

The findings of radiation and environmental monitoring confirm considerable exceeding (in comparison with normal background values) of man-made radionuclide contents in seawater, seaweeds, bottom sediments, vegetation and soil at local parts of the coastal stripe of the STS health protection zone. The radionuclide sorption examination in soil and ground water permits to assume effective migration from the contaminated areas via ground water and following radioactivity intake by the marine media at the off-shore water area. Taking into account further contamination of the STS area, observation of the radiation situation dynamic change should be continued both under regular operation mode and during the SNF and RW removal operations.

RADIOLOGICAL CONTROL AND MONITORING OF THE ENVIRONMENTAL CONDITIONS

At the facilities under inspection for the purpose of the dynamic control of the radiation situation the radio-ecological monitoring system was arranged. It presupposes regular radiometry inspections in-situ, their analysis and assessment of the radiation situation forecast in the course of the STS remediation main stages. The analytical part of monitoring is implemented in the software product developed – geo-informational system based on the Rockville software (GIS). The Environmental radiation monitoring findings served as a basis for the associated databank arrangement. This database is constructed as a number of tables relating to each environmental component under inspection (gamma background, water, soil, vegetation, etc.) and time of sampling. The experimental results received have been plotted on the electronic maps of the place with different information layers The visualization of the data is implemented either as the construction of iso-curves of different intensity related to the geographic location of the facility, or as the depth-of-soil radionuclide distribution (fig.6).

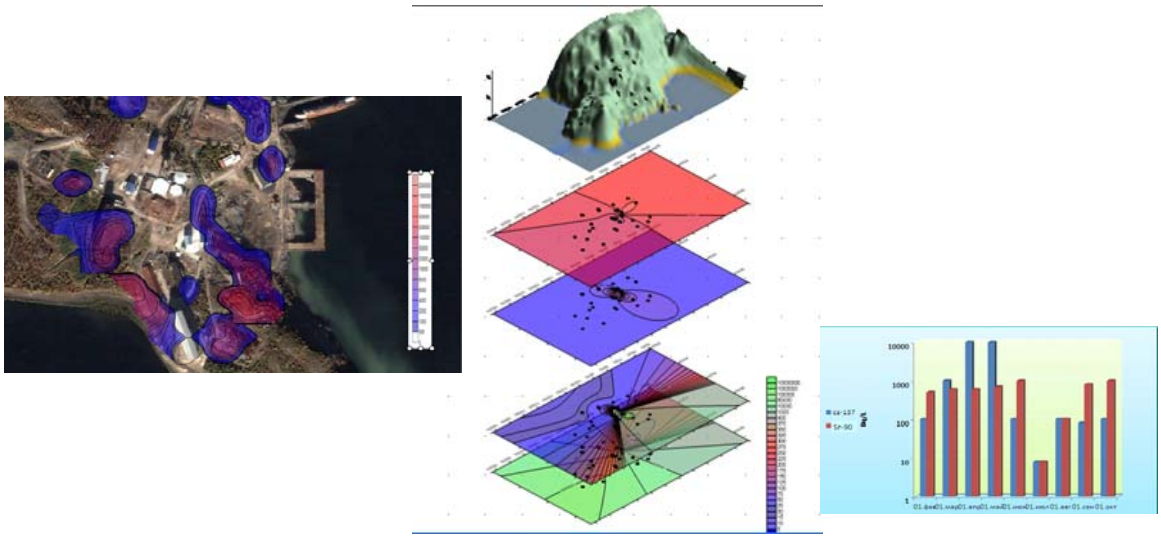


Fig.6 Optional windows in the developed database.

The analytical part of the software includes a search for the points necessary to get more comprehensive and statistically valid information on the radiation situation (the extrapolation approximation method), prognostic assessment of the radionuclide migration in soil on the basis of the calculation algorithms and primary materials (for example, types of soil) and the safety factor evaluation at the stage of the site remediation according to the given scenario. The safety factor makes it possible to evaluate the effectiveness of remedial operations. Further steps relate to generation of full GIS, which permits to carry out the computer calculation of the main indexes for simulation and prognosis of radio-ecological situation with the purpose of the radiation safety regulation.

CONCLUSIONS

This work (concerning the Kola Peninsula) is being implemented under the joint contract between the Federal Medical Biological Agency and Norwegian Radiation Protection Authority. In general, this work deals with the regulation of radiation protection of staff and population during the STS operations. The work completed and activities in progress will help to solve many problems. However, as the working out of technical projects take into account more specific details, some new data on the radiation situation at the facilities will appear in future and the prognostic assessment will become more precise. The continuation of the regulatory work will be focused on the following issues: (1) the extension of the GIS support, (2) the review of design materials on new technical solutions on the SNF and RW management; (3) the selection of the best remediation option.

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