The joint Norwegian-Russian Regulatory Cooperation Program regarding remediation of Andreeva Bay

The Norwegian Radiation Protection Authority (NRPA) is involved in a regulatory cooperation program with the Russian Federation. Regulatory enhancements for nuclear safety culture and radiation protection in relation to legacy sites along the Barents Sea coastline, particularly the Site for Temporary Storage (STS) facility at Andreeva Bay, is an important focus topic.

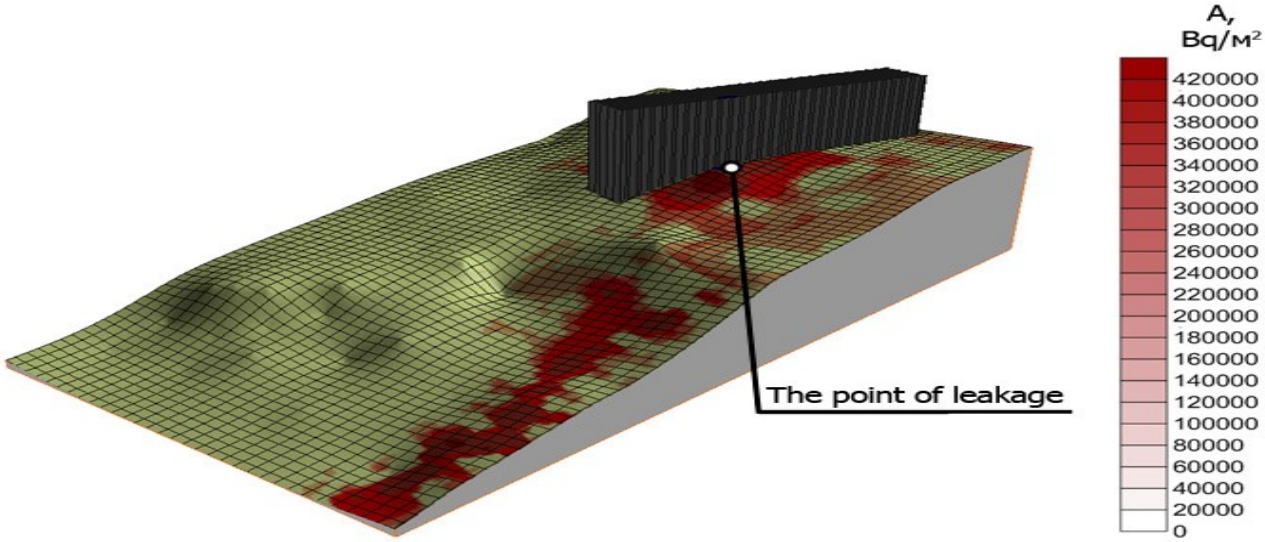

Fig. 1 **Three-dimensional model of the distribution of surface activity in the area of the stream flowing out from under Building No. 5 , Andreeva Bay STS (source: SRC-FMBC).**

The joint Norwegian-Russian projects, under Regulatory Cooperation Program, are focusing on improving of the regulatory framework. It is based on scientific support, which is the key driver for regulatory activities. The work is financed through the Ministry of Foreign Affairs Nuclear Action Plan.

The cooperation program addresses a broad range of activities focused on solving of specific safety problems. The program includes dialogue with stakeholders, sharing of information in working groups, review of draft documents and promoting the cooperation via discussions in wider international forums.

Cooperation with the Federal Medical Biological Agency of Russia (FMBA) considers radiation protection issues related to the remediation of the Andreeva Bay site and emergency preparedness and response.

The key outputs include enhanced regulatory requirements and guidance for planning and response in case of abnormal situations at nuclear legacy sites and supporting an efficient regulatory process to improve radiation safety and protection during remediation.

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Radiation-hygienic support for SNF removal from DSU 2A at Andreeva Bay Facility

Spent nuclear fuel (SNF) at the Andreeva Bay site is stored in simple containers placed in “dry" storage facilities, never intended for this purpose. The SNF storage facility consists of individual storage units (DSUs) of cylindrical form – unit 3A, unit 2A and unit 2B. The DSUs are cylindrical, half-buried, structures with diameters of 18 m and approx. volumes of 1000 m^3 each.

Large-scale operations at Andreeva Bay site have already begun and include the removal of SNF from the DSUs.

Fig. 2 Technological hall of Building 153 (in the foreground - DSUs 2A and 2B, in the background - DSU 3A) (source: SRC-FMBC)

Some spent fuel assemblies (SFAs) stored at the Andreeva Bay site have various defects, such as, violations of geometric size, form and integrity of the SFA. These defects can hamper the extraction of SFAs from DSUs and reloading the SFAs to transport containers. SFAs with defects are classified as “abnormal”. Violations can include the following:

- damage and deformation of the SFA head;
- structural breaks of the SFA;
- SFA jammed in the case pipe;
- damage to the outer casing of SFA and claddings
- deformation or the absence of case plug clip;
- jamming of the plug screw clamp;
- jamming of the plugs in the case.

In some cases fuel cannot be unloaded from the DSUs using regular tools and require special approaches and the development of organizational measures and technical means of protection to ensure the radiation protection of the personnel.

Removal of SNF from the Andreeva Bay site is divided into stages. The first stage is focused on the removal of “normal” SFAs, without any defects or form violations.

The regulatory recommendations on safe management of the normal SNF at the Andreeva Bay site were developed under the joint NRPA-FMBA program, taking into account the findings of the analysis and assessment of a set of technological documentation relevant for operations on the SNF unloading and removal from DSU cells.

Accepted solutions and operational technology (procedure) for the SNF removal will now be analyzed in compliance with the existing regulatory documents and assessment of the radiation parameters and doses to workers in the main working areas.

Fig. 3 Reloading container for SFA (left). Transport package container (right) (source: SRC-FMBC).

This is the basis for development of recommendations on the optimization of protection for workers and the public during the management of normal and abnormal SNF.

Occupational Radiation Protection.

Optimization of radiation protection of workers during remediation is among the crucial issues during handling of SNF.

As part of the Program, the implemented software system (EasyRAD) was developed, designed to solve tasks associated with the regulatory supervision of workers radiation exposure, supporting the efficient regulatory supervision of STS remediation works, calculation of radiation fields, input of the personnel routes and basic radiation situation analysis.

Another tool implemented at the site is the Andreeva Planner (AP), a 3D desktop tool for simulating work scenarios, with radiation visualization and dose-rate charts for scenario participants.

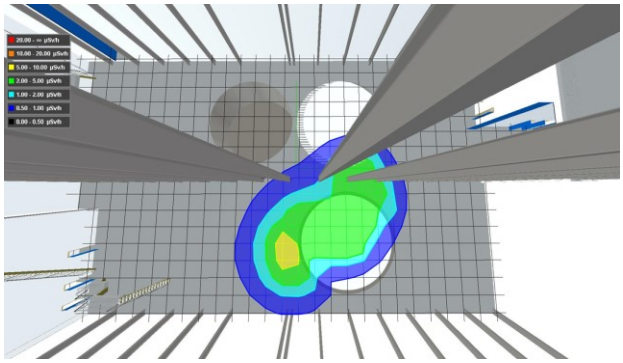


Fig. 4 Example of ADER interpolation for one set of ADER measurements that was made at 32 control points. (source: SRC-FMBC)

The software is designed for 3 step optimization: change of the trajectories and time spent in certain sectors of the scenario, installation of additional shields and modification of current shields, change of the number of participants.

The latest project envisages the improvement of the analytical task of the surface contamination density restoration based on AEDR grids. This m ethod will allow for the usage of both the EasyRAD and Andreeva Planner software jointly for dose assessment based on dose rate measurement data and based on information about the location of radioactive sources and their activity.

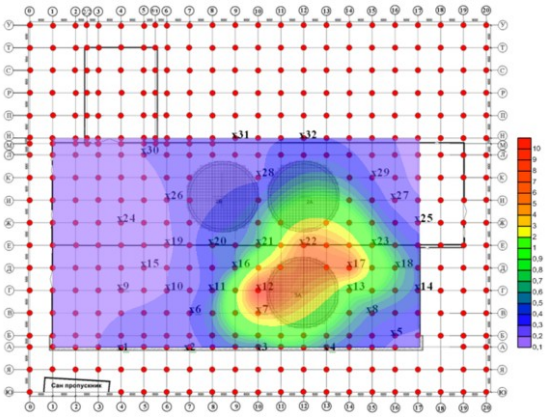


Fig. 5 The ADER field in Room 101 of Building 153 (top view) calculated by the Andreeva Planner Dose Calculator. (source: SRC-FMBC)

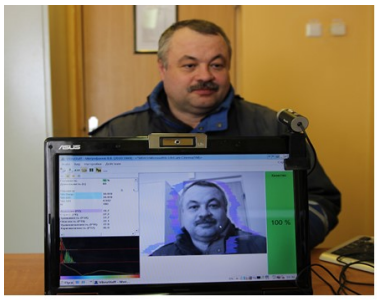
Personnel reliability monitoring

The objective of this project is to improve regulations for personnel training. The project developed remote tools and methods and criteria for the professional reliability monitoring of the facilities involved in decommissioning/management of spent nuclear fuel and radioactive waste.

In the first stage, attention was put on the development of hardware and criteria for pre/post-shift monitoring of psycho-physiological conditions of personnel using vibro-image parameters.

In the next step, it is planned to develop the recommendations describing the methodology of the process.

In further work, vibro –image characteristics and laboratory studies of the behavioral responses based on vibro-image parameters will be used for improvement of the criteria for assessment of psycho-physiological adaptation of workers during annual psycho-physiological examinations.



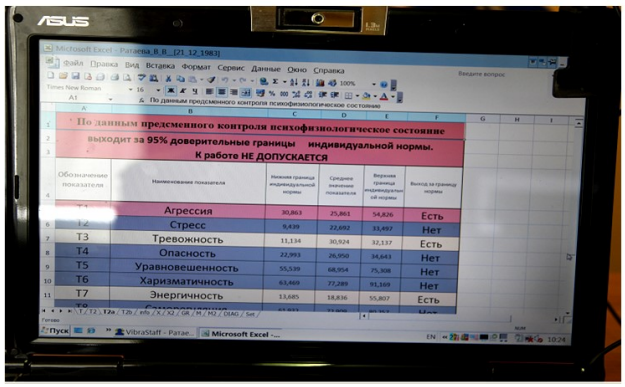


Fig. Overview of SHC "SMENA" (top left). Vibro-image (top right). SHC "SMENA" working window on the admission / non-admission to work (bottom). (source: SRC-FMBC).

Radioecological monitoring at the technical site and around the Andreeva Bay during SNF removal operations

Information on the dynamics of monitored parameters of the radio-ecological situation and other associated data are necessary for successful long-term regulation of remedial operations at the Andreeva Bay site.

To observe the dynamics of the radio-ecological situation and perform prognoses on its further development, generalization and analysis become relevant issues. In light of this, the NRPA program designed and introduced into practice a database on the radiation situation at the site, including a map of radio-ecological data.

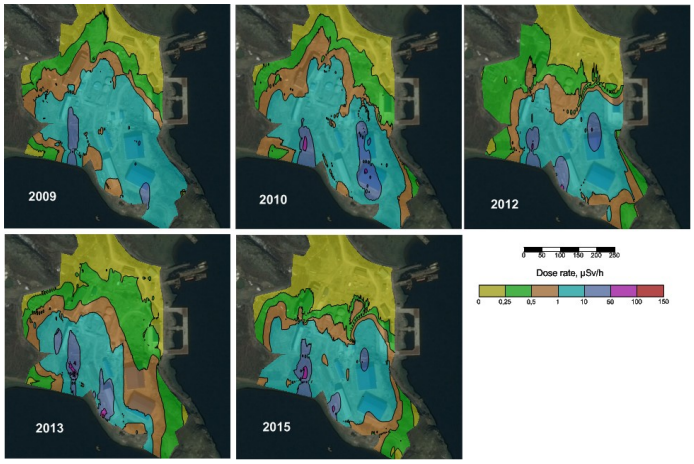


Fig. 7 Dynamics of gamma dose rate at the industrial site over 2009-2015. (source: SRC-FMBC).

Current activities are focused on radio-ecological monitoring at the Andreeva Bay during SNF removal operations. Monitoring includes the marine offshore water area contamination. It is anticipated that the dynamics of radioactive contamination over the entire monitoring period including impact of SNF removal operations on the radio-ecological situation at the site will be assessed.

Conclusions

The Norwegian-Russian Regulatory Cooperation Program adopted an holistic approach since its beginning, taking into account that the radiation protection of workers and the environment includes a wide range of issues, which must be addressed simultaneously to achieve credible results.

The program engages relevant Russian regulatory authorities, operators and other organizations to develop drafted norms, standards, regulatory guides and procedures, while promoting open dialogue.