

**Progress in Norway's Bi-Lateral Cooperation Program on Regulatory Supervision of Legacy Site Management: the Role of International Recommendations - 10191**

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**ABSTRACT**

The Norwegian Radiation Protection Authority has been implementing a regulatory support program in the Russian Federation for over 10 years, as part of the Norwegian government's Plan of Action for enhancing nuclear and radiation safety in northwest Russia. The program includes cooperation with the key Russian regulatory authorities: the Federal Medical-Biological Agency, the Federal Environmental, Industrial and Nuclear Supervision Service of Russia and, most recently, the Directorate of State Supervision over Nuclear and Radiation Safety of the Ministry of Defense. Significant project outputs have been prepared and subsequently confirmed as official regulatory documents of the Russian Federation. The program now focuses on the practical application of this regulatory output to major industrial projects to remediate nuclear legacy sites and to safely manage the spent nuclear fuel and radioactive waste arising from that remediation work. Coordination among all the relevant Russian regulatory authorities is clearly important, especially as facilities change status from military to civilian control. Also important is coordination with operators and technical support organizations, including international agencies. These links are considered critical to effective and efficient regulatory supervision which takes into account relevant international recommendations as well as good supervision practice in other countries. The NRPA therefore supports the recent IAEA initiative to set up an International Forum for Regulatory Supervision of Legacy Sites. This paper describes the recent progress in the above program and explores how international recommendations and cooperation can contribute to the enhancement of nuclear and radiation safety in practical cases at the national and regional level.

**INTRODUCTION**

The Norwegian Radiation Protection Authority (NRPA) has been implementing a regulatory support program in the Russian Federation for over 10 years, as part of the Norwegian

government's Plan of Action for enhancing nuclear and radiation safety in northwest Russia. The program includes cooperation with the key Russian regulatory authorities: the Federal Medical-Biological Agency (FMBA), the Federal Environmental, Industrial and Nuclear Supervision Service of Russia (Rostekhnadzor) and, most recently the Directorate of State Supervision over Nuclear and Radiation Safety of the Ministry of Defense (DSS NRS). The project outputs have included appropriate regulatory threat assessments, to determine the hazardous activities which are most in need of enhanced regulatory supervision [1]; and development of the norms, standards and regulatory procedures, necessary to address the often abnormal conditions at nuclear legacy sites [2], [3]. With the fundamental input of Russian technical support organizations, project outputs have been prepared and subsequently confirmed as official regulatory documents of the Russian Federation.

The program is now very much focused on the practical application of this output to major industrial projects to remediate nuclear legacy sites and to safely manage the spent nuclear fuel (SNF) and radioactive waste (RW) arising due to these remediation activities. All three authorities mentioned above are involved, as facilities change status from military to civilian control and as SNF and RW are prepared for transport to and storage at central storage facilities. Coordination among them is clearly important, and the NRPA actively allows for this in project planning and implementation. Also important is coordination with the Russian government and companies responsible for carrying out the remediation work, as well as the western donors and support organizations. The NRPA therefore actively participates in the International Atomic Energy Agency's (IAEA) Contact Expert Group (CEG) which provides an important additional communication mechanism.

All these links are considered vital. Although the responsibility for regulatory supervision lies with Russian authorities, in accordance with the requirements of the Russian Federation legal framework, these authorities also take into account relevant international recommendations and include review of supervision practice in other countries. The NRPA takes the view that much can be learned from sharing experience in this area, noting the existence of nuclear legacy sites in many other countries. The NRPA therefore also supports the recent IAEA initiative to set up a Forum for Regulatory Supervision of Legacy Sites for this purpose. Apart from sharing of technical experience, the Forum provides a mechanism for discussing the interpretation of IAEA recommendations and allows for feedback to the IAEA on the future evolution of those recommendations as they apply to legacy site issues.

The following sections of this paper set out the current status of the program described above and explore how international recommendations can contribute to the enhancement of nuclear and radiation safety in practical cases at the national, regional and site specific level.

## **REGULATORY AND SITE CONTEXT**

In the 1960's, two shore technical Navy bases (STBs) were built in Northwest Russia, one at Andreeva Bay and another in Gremikha on the Kola Peninsula on the Barents Sea coastal strip. These facilities supplied operational support to nuclear submarines of the Northern fleet, including storage of SNF and RW. After two decades of operation, the Treaty on the Non-proliferation of Nuclear Weapons called for functional decommissioning of a large number of nuclear submarines (NS) within a relatively short period, from the late 1980's to early the 1990's. This gave rise to increased attention from the international community to the circumstances in northwest Russia.

In 2000, by Decree of the Russian Government, the Federal State Unitary Enterprise SevRAO was established with the purpose to conduct the full set of operations for management of the SNF and RW accumulated in the process of NS decommissioning, and to carry out environmental rehabilitation of radiation hazardous facilities in the Northwest Russia. The main SevRAO remediation activities have been centered upon the former shore technical bases in Andreeva Bay and Gremikha, now designated as Sites of Temporary Storage (STS).

The following circumstances critically characterized these sites:

- Unsatisfactory technical condition of the STS facilities, hampering safe SNF and RW management;
- Radioactive contamination dispersion from the areas of STSs in the adjacent marine environment;
- Lack of regulatory requirements and guidance to deal with the existing abnormal radiation conditions, and
- Lack of relevant standards for the complete management of radioactive waste.

In addition to the high concentration of radiation-hazardous facilities in the region, the following factors exacerbated the problem of management of these legacy sites:

- Damage to the SNF and the engineered barriers of the storage facilities, leading to radioactive contamination of the environment, and a continuing threat of further releases;
- Gaps in regulations on procedures connected with specific aspects of SNF and RW management, including insufficient definition of requirements for remediation activities; and
- Justified public concern that environmental safety may be jeopardized not only in the area of the Kola Peninsula and in the European part of Russia, but also in other countries of northern Europe.

The Russian strategy for addressing this situation draws support for a wide range of industrial projects which in turn receive support from donor organizations and technical institutions, coordinated through the IAEA's CEG. Progress with these projects was presented and discussed

at a workshop in Rome in October 2009, and the material is conveniently summarized at:  
[http://www.iaea.org/OurWork/ST/NE/NEFW/CEG/ceg\\_plenary23.html](http://www.iaea.org/OurWork/ST/NE/NEFW/CEG/ceg_plenary23.html)

The NRPA's regulatory support program was designed to provide parallel support to the Russian regulatory authorities, with a view to ensuring that investments made to manage the nuclear legacy in northwest Russia would be spent safely within the context of an effective regulatory regime.

## **PROGRESS WITH REGULATORY DEVELOPMENT**

The strategy within the regulatory support program has been to first analyze the current radiation situation and identify those radiation and nuclear safety issues which are significant in themselves but which are also in most urgent need of improved regulatory development to help in their resolution in accordance with relevant radiation protection and other safety principles. We have called this first step a regulatory Threat Assessment [1]. The follow-up work to develop better independent characterization of the radiation situation at the SevRAO sites was described at WM2008 in reference [2], since when further reports have been published dealing with specific regulatory issues [3 – 8].

Reference [3] sets out the justification for the specific program of regulatory development at the Andreeva and Gremikha STSs in relation to strategic options for site remediation. Radio-ecological condition assessment and environmental remediation criteria for each option are provided in references [4] and [5]. The hazardous working conditions, in radiation terms, which will arise in work to recover SNF and RW from their current inadequate stores, are given in reference [6], alongside recommendations for control and supervision of individual radiation exposure. Medical and radiological aspects of emergency preparedness and response are described in reference [7]. Reference [8] sets out the hygienic requirements for industrial waste management at the SevRAO sites. In effect, these requirements provide for the definition of and safe management of very low level radioactive waste (VLLW), but coherent account has been taken of the other hazardous components of this material and the corresponding requirements for the management of industrial hazardous waste.

The program has resulted in the timely development of official regulatory guidance and reports as follows:

### **1. Personnel Radiation Safety:**

- Methodical guidance "Requirements for performance of personal radiation monitoring for personnel of FSUE SevRAO Branch № 1".
- Methodical document "Regulation for performance of radiation monitoring at FSUE SevRAO Branch № 1".
- Methodical guidance "Special features in application of ALARA principle in the work on SNF and RW management at FSUE SevRAO Branch № 1".

### **2. Control of environmental contamination:**

- Development of radio-ecological criteria of marine environmental monitoring and control in the course of STS rehabilitation, taking account of possible end-state of the object.
  - Development of methodical guidance documents “Radioecological monitoring on-site and in supervised area in the course of conversion activities at STS of SevRAO.”
3. Criteria for on-site management of Very Low Level Waste (VLLW):
- Development of sanitary hygienic requirements for collecting, categorization, treatment, temporary storage, transportation and disposal of VLLW in the territory of the SevRAO facility at Andreeva Bay.
  - “Safety norms on VLLW management containment safety requirements for the period of operation of the facility and upon its closing, as well as the criteria for waste acceptance”.
4. Criteria development for emergency preparedness and response:
- Report “Analysis of Russian and international approaches in evaluation of operating radiological and medical criteria at an early stage of emergency response”.
  - Guidance on application of radiological and medical criteria by MSU-120 and RM-120 emergency response teams as part of emergency response system.

These documents were required to:

- Create a system covering the entire range of the objectives related to medical-hygienic regulation of radiation and environmental protection of the personnel, public and environment at SevRAO facilities;
- Optimize the order of the works, by means of selection of acceptable technologies, and assess the radiological, economical and social factors, and accordingly, provide for and guarantee a series of preventive and operative measures;
- Guarantee a socially acceptable level of radiation protection and public health during and after termination of operations at SevRAO facilities, basing on common approaches to the national normative documents and international recommendations, and
- Identify the perspectives in improvement of the regulatory system within the framework of international co-operation, basing on a detailed assessment of the scale of potential threats.

This work has been particularly relevant so as to provide a sound basis for the design and development of remediation operations within a proper regulatory framework. That is to say, the approach is to address the entire program of remediation work, not just this or that aspect. The set of regulatory documents prepared in the course of the work has been published in reference [9].

Benefit has been taken from shared international experience with substantial support from NATO, as illustrated in reference [10].

## **CURRENT REGULATORY DEVELOPMENT PROJECTS**

The above work can be said to have supported the development of updated and enhanced regulatory requirements which address the situations at the STSs. The continuing NRPA regulatory support program is now able to focus on the implementation of regulatory supervision

of remediation operations, practically to monitor compliance with the requirements. Accordingly, through 2008 – 2009, projects with FMBA have been under way as follows, involving experts from the Federal Medical Biological Center (FMBC).

### **Emergency Response Training Exercise**

The goal of the project was the improvement of the emergency preparedness of managerial systems, emergency teams and establishments of emergency response in case of radiation accident at the FSUE SevRAO Ostrovnoy affiliated branch at Gremikha. Emphasis was placed on practicing the interaction of emergency response organizations, when applying radiological countermeasures for FSUE SevRAO personnel and Gremikha village residents under the framework of emergency planning and response decisions made by Rosatom and the FMBA. Accordingly, an emergency exercise was organized and carried out:

- to demonstrate and practice the operation of the managerial system and emergency response network of FSUE SevRAO, RM-120, CMSU-120 and FMBC of FMBA of Russia in the event of an accident at FSUE SevRAO STS affiliated branch in Ostrovnoy;
- to practice issues of the interaction between operator and regulator when making urgent decisions and recommendations applying countermeasures action for personnel and the public, and
- to develop recommendations for necessary countermeasures for managerial bodies.

The exercise took place successfully in June 2009, despite the difficult weather conditions at the time and the remoteness of the location.

### **DATAMAP: Radio-ecological mapping at Andreeva Bay**

The main idea of the project is to integrate all relevant radio-ecological data, i.e. radiation situation parameters, landscape information, and hydrogeological as well as geochemical data, within maps of the STS area in Andreeva Bay. A geo-information system has been developed allowing:

- analysis of the current radio-ecological situation at STS, e.g. to identify areas which require remediation and or further data sampling to ensure adequate control;
- prognosis of changes of radio-ecological situation, e.g. due to radioactive decay and migration of contamination from its current location, and
- optimization of radiation monitoring and methods of remedial work implementation.

The geo-information system is intended for regulatory and supervision bodies, operators and for persons involved in processes of STS remediation in Andreeva Bay.

### **DOSEMAP: Mapping of radiation situation in workshops**

The primary objective of the project is to support the regulation of personnel radiological protection in the course of the second stage of work, in terms of specificity of its

accomplishment under real SevRAO conditions, including particularly hazardous SNF and RW removal activities. A mapping system has been developed allowing:

- Analysis of the radiation situation inside workshops,
- Calculation of internal and external radiation exposure linked to particular assumptions for remediation operations, for example to identify optimal routes for movement and transfers, and
- Recording of radiation exposures of individuals involved in the work.

Recommendations are also being developed for operators of the SevRAO facilities on application of the developed databases for planning and optimization of radiation hazardous operations.

### **Radiation Protection Requirements for the Saida Bay Centre of Conditioning and Long-term Storage of RW**

In the course of STS remediation, SNF are planned to be removed for processing at PA "Mayak", while RW generated, as well as RW resulted 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, at Saida Bay. The project objective is to develop the regulatory requirements for occupational, public and environmental protection assurance during arrangement and implementation of radioactive waste management at the Center. Good progress has been made and draft requirements have been developed, which allows for the better planning of RW management at the STSs, in preparation of RW for transfer to Saida Bay.

### **Personnel Reliability Management**

It is typically recognized that human factors are a significant aspect in causes of accidents. This project is to:

- analyze important occupational psychological and psycho-physiological characteristics of workers involved in the SNF management, and to study methods of their assessment;
- develop medical and technical requirements for the expert-and-diagnostic system of risk monitoring of the performance reliability violation of persons involved in SNF management;
- develop relevant criteria of persons with negative prognosis of their performance reliability on the basis of psychological and psycho-physiological information;
- develop hard/soft-ware and informational tools of risk monitoring of the performance reliability violation within the expert-and-diagnostic information system («EDIS\_ST»); and
- develop proposals for organization of the system for performance reliability assurance of persons involved in SNF management, so as to improve radio-ecological safety at the STS.

The relevant hardware and software tools have been developed and are in the process of being tested in an operational environment.

Apart from these projects with FMBA/FMBC, two further regulator support projects have been in progress.

### **Guidelines to Re-categorize Nuclear Materials as Radioactive Waste**

The objective of this project is the development of regulatory guidance on re-categorizing nuclear materials as RW. It is being carried by the International Centre for Environmental Safety (ICES). The need arises because of the potential for small fragments of SNF to arise within RW during the course of remediation work at the SevRAO STSs. In effect, the output will include waste acceptance criteria for the RW being delivered to the SevRAO facility №3. The scope of the project is limited to the regulatory functions of supervision exercised by the DSS NRS of the Russian Federation Ministry of Defence over provision of nuclear and technical aspects of radiation safety. However, the project addresses issues of effective interaction with others supervision authorities of Russia, necessary within the development and implementation of a national policy on SNF and RW management. The work also takes into account international recommendations and includes a review of good supervision practice in other countries, such as the justification and explanation of waste acceptance criteria for storage and disposal facilities.

### **Supervision of Radio-Thermal Generator (RTG) Decommissioning**

The NRPA regulatory support program has included support to the development of regulatory supervision over RTG decommissioning [11]. The ongoing RTG decommissioning program necessitates an analysis of expertise that has been accumulated over previous years to advance the consistent practical application of regulatory documents and processes at all RTG decommissioning stages and with regard to all RTGs. Therefore, it is of utmost importance to inform regional inspectors and operators, as well as representatives of controlling organizations and those rendering services, on regulatory requirements and procedures, and provide them with practical guidance on such applications. The objective of this project is therefore to improve the existing safety regulatory framework of the Russian Federation as regards safe decommissioning and disposal of RTG with the focus on the priorities below:

- Explanation of regulatory requirements and rules;
- Completion of full-scale threat assessments base to support licensing decisions;
- Enhancement of in-depth supervision over radiological safety and introduction of a new supervision approach as necessitated by reported RTG-related events; and
- Supervision over emergency preparedness.

### **NEXT STEPS IN COORDINATION INITIATIVES**

Many countries have sites which remain as legacies to be managed after the initial phases of nuclear technology development, notably facilities linked to research, development and experimentation in both nuclear electricity generation and military applications. Therefore, major legacy sites exist in those countries in which nuclear technologies were extensively developed, such as the USA, the Russian Federation and the former Soviet Union countries, France, the



United Kingdom and China. These sites are contaminated with both toxic and radioactive residues. Radioactive contaminants include fission and fuel activation products as well as isotopes from the natural uranium and thorium decay chains.

In the course of the above work, the NRPA and Russian experts have increasingly recognized the need for improved coordination among the different regulatory authorities and the different civilian and military operators. As in other countries, the situation is very complex, because of the long history leading to the current legacy situation and because of the scale of the operations.

Legacy sites were created at a time or within a context where regulatory supervision of operations was weak or absent for nuclear safety and radiation protection of human health and the environment. Nowadays, strong and independent regulatory supervision is seen as a critical factor in provision of radiation and nuclear safety during operations at nuclear sites. In some cases, this implies a major cultural move by the operators of legacy sites and some adjustments from the regulatory supervision side. Much has been done through international cooperation, to enhance regulatory supervision of nuclear power plants and other aspects of the nuclear fuel cycle operations. Up to now, comparatively little has been done internationally or regionally to enhance regulatory supervision of the remediation of legacy sites or to share experiences in addressing the multi-faceted aspects of radiation and nuclear safety at legacy sites. The IAEA has therefore set up an international Forum on Regulatory Supervision of Legacy Sites (RSLs) that will enable regulatory authorities to network on the particular context of the remediation of legacy sites.

The NRPA plans to support this development since it complements so effectively their current bilateral programs. Planned activities include:

- Support to development of new regulations and regulatory guidance, which address unusual situations arising in actual legacy situations at specific sites.
- Support to development of regulatory procedures for licence application review, and for monitoring compliance with licence conditions in actual legacy situations at specific sites.
- Support to development of methods for environmental impact assessment, so as to build confidence into prospective assessments of possible future situations. These assessments relate to the demonstration of regulatory compliance with safety limitations, but also the demonstration of optimisation from among a set of alternative management strategies.
- Development of guidance and recommendations regarding the application of optimisation at the national strategic and site specific levels, based on the practical experience from different countries.
- Development of international guidance on regulatory supervision of legacy sites.
- Peer reviews of regulatory of regulatory activities pertaining to legacy sites.

## **CONCLUDING REMARKS**

Substantial progress has been made within the Russian Federation to manage the nuclear legacy and remediate legacy sites within a modern and effective regulatory system. This has been

achieved by more than simplistic application of international recommendations and some training courses. These are important, but the main enhancements have come through support projects which have had direct application and practice at real sites, as has been done at Andreeva and Gremikha STSs, and as is now being extended to the treatment and storage facilities at Saida Bay. To be successful, this has required the building of trust and close cooperation among many organizations: regulatory authorities, operators and technical support organizations, but also local authorities and other stakeholders.

Further work continues to enhance the processes of regulatory supervision of workers, the public and the environment, in the context of radiation protection and nuclear safety. A major challenge is the development of safe systems for final disposal on RW.

The challenges are similar to those arising in other countries which have developed major nuclear infrastructures. International cooperation and sharing of experience can make a major contribution to improving safety supervision, learning from successes and failures. These lessons may include technical solutions but also organization and regulatory supervision methods. The IAEA Forum on Regulatory Supervision of Legacy Sites will play a major part in this.

We can share common safety and protection objectives, but, as suggested at a recent workshop arranged by the Nuclear Energy Agency ([http://www.nea.fr/html/rp/vaulx\\_de\\_cernay09/welcome.html](http://www.nea.fr/html/rp/vaulx_de_cernay09/welcome.html)), different methods may be appropriate in different locations, because of many factors: technical, institutional, geographical, social and cultural. Working to achieve the optimum result is a complex process, and development of a theoretical best should not detract from making progress in a timely and effective manner.

## **REFERENCES**

1. L ILYIN, O KOCHETKOV, A SIMAKOV, N SHANDALA, M SAVKIN, M K SNEVE, P BORRETZEN, A JAWORSK, G M SMITH, I BARRACLOUGH and P KRUSE, "Initial Threat Assessment. Radiological Risks Associated with SevRAO Facilities Falling Within the Regulatory Supervision Responsibilities of FMBA", Strålevernrapport 2005:17. Østerås: Statens strålevern, (2005).
2. M K SNEVE, N K SHANDALA AND G M SMITH, "Progress in Norwegian-Russian Regulatory Cooperation in Management of the Nuclear Legacy", In Proceedings of "Waste Management 2008" Conference, February 24 – 28, Phoenix, AZ, (2008).
3. N K SHANDALA, M K SNEVE, G M SMITH, M FKISELEV, O A KOCHETKOV, M N SAVKIN, A V SIMAKOV, N YA NOVIKOVA, A V TITOV, V ROMANOV, V A SEREGIN A V FILONOVA AND M P SEMENOVA, "Regulatory supervision of sites for spent fuel and radioactive waste storage in the Russian Northwest.", Journal of Radiological Protection, Volume 28, No 4, (2008).
4. N K SHANDALA, M F KISELEV, M K SNEVE, A V TITOV, G M SMITH, N YA NOVIKOVA AND V V ROMANOV, "Radioecological condition assessment and remediation criteria for sites of spent fuel and radioactive waste storage in the Russian

- Northwest”, in Proceedings of 12th International Radiation Protection Association Conference, Buenos Aires, (2008).
5. N K SHANDALA, M K SNEVE, A V TITOV, G M SMITH, N YA NOVIKOVA, V V ROMANOV AND V A SEREGIN, “Radiological criteria for remediation of sites for spent fuel and radioactive waste storage in the Russian Northwest. Journal of Radiological Protection, Volume 28, No 4, (2008).
  6. A V SIMAKOV, M K SNEVE, YU V ABRAMOV, O A KOCHETKOV, G M SMITH, A G TSOVIANOV AND V V ROMANOV, “Radiological Protection Regulation during Spent Nuclear Fuel and Radioactive Waste Management in the Western Branch of FSUE SevRAO”. Journal of Radiological Protection, Volume 28, No 4, (2008).
  7. M N SAVKIN, M K SNEVE, M I GRACHEV, G P FROLOV, S M SHINKAREV AND A JAWORSKA, “Medical and radiological aspects of emergency preparedness and response at SEVRAO facilities.”, Journal of Radiological Protection, Volume 28, No 4, (2008).
  8. FEDERAL MEDICAL BIOLOGICAL AGENCY, “Hygienic Requirements for Industrial Waste Management at the Federal State Unitary Enterprise Northern Federal Enterprise for Radioactive Waste Management”. R ONAO SevRAO-08, Guidance R 2.6.5.04 – 08. Moscow, (2008).
  9. NRPA, “Regulatory Improvements Related to the Radiation and Environmental Protection during Remediation of the Nuclear legacy Sites in North West Russia. Report of work completed by NRPA and FMBA of Russia in 2007”. Norwegian Radiation Protection Authority, Strålevernrapport 2008:7. Osteras, (2008).
  10. N K SHANDALA, A V TITOV, N YA NOVIKOVA, V A SEREGIN, M K SNEVE AND G M SMITH, “Radiation Protection of the Public and Environment near Location of SevRAO Facilities. In proceedings of a NATO Advanced Research Workshop, Challenges in Radiation Protection and Nuclear Safety Regulation of the Nuclear Legacy”, Ershovo, September 2007. Springer, Dordrecht, (2008).
  11. M K SNEVE AND V REKA, “Upgrading the Regulatory Framework of the Russian Federation for the Safe Decommissioning and Disposal of Radioisotope Thermoelectric Generators”, StrålevernRapport 2007:5. Østerås: Norwegian Radiation Protection Authority, (2007).