

## **RTG Decommissioning: Regulative and safety issues, NRPA – Rostechnadzor Regulatory project**

### **C. DEREGEL (IRSN France), M. K. SNEVE (NRPA Norway)**

The French Institute for Radiation Protection and Nuclear Safety (IRSN) has participated to the Norway-Russian Federation RTG decommissioning Regulatory Support project. This activity was part of the French contribution, under the framework of the G8 Global Partnership, to the decommissioning of radioisotope thermoelectric generators deployed in the Russian Federation (dismantling and storage in safe places of the very high activity radioactive sources they contain).

The Norway-Russian Federation project (project leaders M. K. SNEVE (NRPA) and V. REKA (Rostechnadzor) “Upgrading the regulatory framework of the Russian Federation for the safe decommissioning and safe disposal of radioisotope thermoelectric generators” was divided in 6 tasks:

- Assessment of current regulatory requirements and regulations for radiation protection and safety (task leaders: G. SMITH (Enviros U.K.) and V. SKUGAROV (Rostechnadzor)
- Review of applications for licensing and authorisations (Task leader (Facilia Sweden) and V. REKA (Rostechnadzor),
- Adaptation of procedures for monitoring of radiological safety (taskleaders: C. DEREGEL (IRSN France) and V. REKA (Rostechnadzor),
- Improvement of regulatory activities in the area of emergency preparedness (task leaders: I. EIKELMANN (NRPA Norway), V. REKA (Rostechnadzor) and V. SEMPELEV (SEC NRS),
- Physical protection in RTG Decommissioning (Task leaders I. FINNE NRPA and V. PERVIN (Rostechnadzor),
- Environmental impact assesement review for RTG dismantling, transportation, temporary storage and disposal (Task leaders: J.O. SNIHS (SSI Sweden) and A. PECHKUROV (Rostechnadzor).

The results of the RTG Regulatory project have been used as a basis for the development of new regulatory documents issued by Rostechnadzor :

- Regulatory guide RD-10-04-2006 put in force in February 2007 “Methodology regarding the procedure for radiation safety supervision during decommissioning, transportation and long-term storage of RTGs” (results of task 3),
- Federal norms and rules NP-074-06 put in force on 1 June 2007 “Requirements for the planning and ensuring of preparedness for elimination of accident consequences during trransporation of nuclear materials and radioactive substances” (results of task 4).

During the final meeting of the project with representatives of the regulator (Rostechnadzor) and of the operators (VO Safety and Kurchatov Institute) in November 2006, following issues were raised:

- The key need for the future in relation to the regulation of RTG decommissioning is to achieve consistent practical implementation of the framework of regulations and processes already in place and enhanced through this project, through all steps of decommissioning and for all RTGs.
- Although there may be scope for further improvements in the framework, regulations and procedures are now in place, and the operators and regulators need to be engaged in understanding them and ensuring that they are applied.

- A significant element of future work will therefore be to raise awareness among the regional inspectors of Rostechnadzor and the operators (and also among the controlling organisations and organisations rendering services) of the regulations and procedures, the reasons behind them, and the importance of applying them.

As a follow-up of this RTG regulatory project and taking account of the Rostechnadzor need in further upgrading its capabilities in the area of radiation safety regulation during RTG decommissioning and transportation, NRPA proposes following activities for 2008 - 2009 :

- to make an analysis of accumulated experience in supervising safety during RTG decommissioning and in mitigating consequences of any incidents and accidents which may occur in the course of the ongoing RTG decommissioning in Russia. It may result in extension of the scope of applicability of the Methodological Guide developed under the previous regulatory project as regards the “operative inspections” procedures which are to be carried out after the incidents and accidents,
- to make arrangements for and conduct of an educational workshop for Rostechnadzor inspectors and, maybe, for personnel of an operating organization and organizations rendering services for the operating organization,
- to carry out a risk assessment of removing Radioactive Heat Source (RHS) from RTG in a hot cell to place the former into transportation packages. The objective is to assess the implications of this process operation on safety,
- to develop a methodological aid (guide) to provide more detailed information to operators, consignees, consignors, carriers and organizations rendering services on how to implement the Federal Standards and Rules related to preparedness and response in case of radiological accidents during transportation,
- to arrange and conduct a joint emergency drill with participation of Rosatom, Rostechnadzor, Russian operators and western experts to improve common understanding of organisations’ roles and procedures to be implemented in case of accidents as well as to facilitate experience exchange among the participants of such exercise.

A detailed description of the project is given in the article published by the IAEA Bulletin 48/1 in September 2006 (Internet links <http://www.iaea.org/Publications/Magazines/Bulletin/Bull481/pdfs/rtg.pdf> (English version) and [http://www.iaea.org/Publications/Magazines/Bulletin/Bull481/pdfs/Russian/article12\\_rus.pdf](http://www.iaea.org/Publications/Magazines/Bulletin/Bull481/pdfs/Russian/article12_rus.pdf) (Russian version)).

To follow, the document used as a basis for the article published in the IAEA Bulletin.

## **A Regulatory Perspective on the Decommissioning of Some of the Largest Single Radioactive Sources - Radioisotope Thermoelectric Generators**

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### **NATURE OF THE PROBLEM**

Several hundred radioisotope thermoelectric generators (RTGs) were deployed and used along the Russian Federation’s Arctic coast to power remote lighthouses. A typical RTG and its installation at a lighthouse are shown in Figure 1. Similar RTGs were also used as power sources in other remote locations in the Russian Federation and elsewhere in the Former Soviet Union, and incidents involving such sources, particularly in Georgia, have been described in previous Bulletin articles.



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Fig 1a) A typical RTG-installation



Fig 1b) A typical RTG ( $^{90}\text{Sr}$  heat source removed)

The RTGs typically contain one or more Radionuclide Heat Sources (RHSs) each with an activity of thousands of TBq of strontium-90. This means that they are Category 1 sources as defined in the international Code of Conduct on the Safety and Security of Radioactive Sources. In fact they are among the largest single radioactive sources ever utilized.

According to information from the Federal Atomic Energy Agency of the Russian Federation (Rosatom), there are currently 651 RTGs at various locations in the Russian Federation which are subject to decommissioning or replacement with alternative sources of energy. In 1993, there were almost 200 RTGs in lighthouses in the Murmansk and Arkhangelsk regions of Northwest Russia, relatively near to the Norwegian border.

Due to the remoteness of these lighthouses and other factors, maintenance and security of the RTGs are difficult to achieve, and there have been several examples of unauthorised interference. While there is no evidence of any intent to use the radioactive sources for malevolent purposes, there have been incidences of theft of shielding materials, presumably for their value as scrap metal, with the RHSs being abandoned.

Naturally, concern has arisen about the potential misappropriation of the radioactive sources as well as the broader issues of continuing maintenance and safe use of RTGs, especially in remote locations. This has become a matter of both national and international concern (see, for example, [CEG, 2005]). The Norwegian Government has taken a significant part in international efforts, in full cooperation with Russian Federation authorities, to safely decommission RTGs and provide alternative power sources.

Norway has been actively engaged in supporting improvement of nuclear safety and security in Northwest Russia for more than ten years, within the framework of a Plan of Action. Over this period, the Norwegian Government has spent more than 1 billion NOK (approximately 150 million USD) on a variety of *industrial projects*. These include specific improvements in radioactive waste treatment and storage, physical security, and infrastructure support. As the national authority, the Norwegian Radiation Protection Authority (NRPA) takes an active part advising the Government regarding prioritization and quality assurance of all these activities.

In addition, the Plan of Action places great emphasis on adequate regulatory supervision. Accordingly, the NRPA programme includes a variety of *regulatory support projects*. These are designed to assist the Russian authorities in ensuring that work is carried out properly within the framework of Russian

Federation law, taking into account international standards and recommendations from bodies such as the IAEA, as well as other national good practice. The regulatory cooperation between NRPA and the various Russian regulatory bodies is an important contributor to an effective and efficient regulatory process, which benefits all organizations.

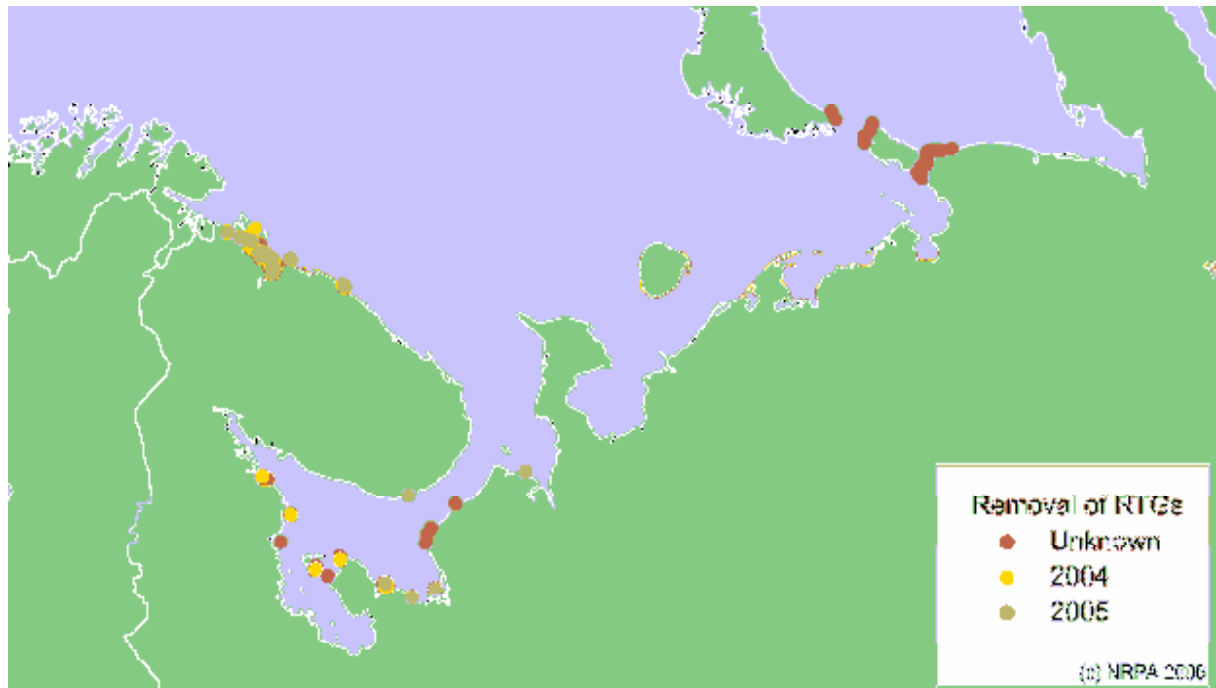


Fig 2) Northwest Russia - places where RTGs were removed with Norwegian support since 1997

## INDUSTRIAL SUPPORT PROJECT FOR RTG DECOMMISSIONING

The Norwegian Government has been operating an industrial project to support decommissioning of RTGs in Northwest Russia since 1997. This has resulted in the removal of more than 60 RTGs from lighthouses on the Kola Peninsula, and their replacement with solar panels and nickel-cadmium battery packs is under way (see Figure 2).

As part of this project, inspection and preparatory work took place before, the RTGs were transferred by helicopter, boat and road to a temporary storage point at ATP "Atomflot" near Murmansk. They were then transported by road and rail to the dismantling point in the Moscow Region, where the heat sources (RHS) were removed. The RHSs were then transported by road and rail to FSUE PA "Mayak", where they are currently stored pending final disposal.

There are important security, environmental and radiological protection incentives for the RTG decommissioning project. The RTGs represent a local environmental and public hazard as well as a possible source of radioactive material which could be misused. On the other hand, the decommissioning process could itself result in radiological or other environmental impacts and risks. In addition, the operational and regulatory responsibilities with respect to RTGs have been evolving in the last few years, including changes from military to civilian control. It was appropriate, therefore, to review the situation and so NRPA, in cooperation with Russian organizations, carried out such a study, "Assessment of environmental, health and safety consequences of decommissioning radioisotope thermal generators (RTGs) in Northwest Russia" [NRPA, 2004; Standing et al, 2005].

It was concluded that the decommissioning project should continue, since leaving the RTGs *in situ*, inadequately monitored, could lead to a risk of undesired access to radioactive material. However, it was also noted that the relevant authorities and organizations need to be clear over their separate responsibilities throughout the entire process of inspecting, collecting, and dismantling RTGs, as well as the storage and disposal of radioactive waste so generated, and that radiation protection guidelines

should be reviewed and amended where necessary with correct procedures and checklists to ensure compliance. The need for regulatory support to help achieve this was recognised.

## REGULATORY SUPPORT PROJECT FOR RTG DECOMMISSIONING

Noting the above conclusions, NRPA has been providing support to regulators in the Russian Federation in parallel with the continuing industrial project. The general goal of regulatory support is to help Russian regulatory bodies in developing guidelines and requirements for planning, licensing and implementation of the industry projects.

NRPA's main partner in the RTG Regulatory Support Project (RSP) is the Nuclear, Industrial and Environmental Regulatory Authority of the Russian Federation, Rostechnadzor. After several years of cooperation with Rostechnadzor on a variety of topics, NRPA recognises that the most efficient cooperation occurs when all relevant organizations are able to work together. For example, while Rostechnadzor is the main regulatory body concerned with regulation of RTG decommissioning, there are interactions with other regulators, for example those concerned with transport. While it is necessary to maintain independence and clear lines of responsibility, it is very helpful to make progress with coordinated actions. This includes operators and regulators from the Russian Federation and support from operators and regulators from the Western organizations. This is the "2 plus 2" approach, as illustrated in Figure 3. Russian and Western operators cooperate on the industry project, and Russian and Western regulators cooperate on licensing/approval of this industry project. In order to provide the most relevant international inputs to Russian regulators, NRPA involves regulators and technical support organizations (TSO) from other countries, including France, Sweden and the UK.

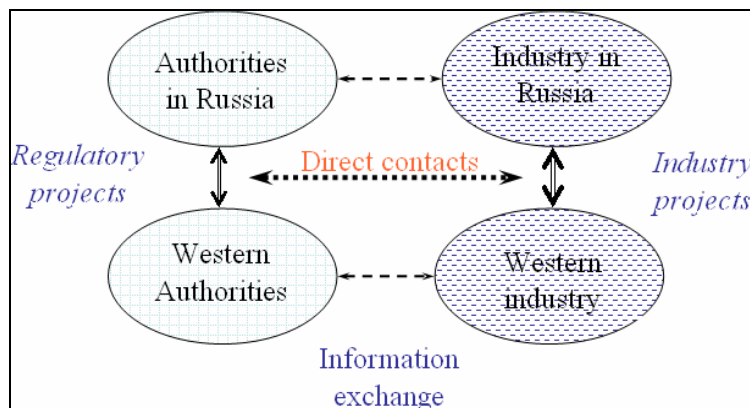


Fig 3) Model for cooperation with 2+2 approach

## INITIAL THREAT ASSESSMENT

As a first step in the RTG RSP, an Initial Threat Assessment was carried out to clarify the steps in RTG decommissioning and to identify priorities for regulatory action, based on the main radiological threats presented by each step. The steps identified were as follows (see also Figure 4):

1. Operator's inspection of RTGs in their place of operation;
2. Recovery of RTGs from their operational locations and loading onto a ship;
3. Transport of RTGs by ship to a temporary storage point (depending on its original location), short-term storage and transfer to train;
4. Transport of RTGs by rail to FSUE VO "Izotop" in Moscow Region;

5. Loading onto trucks and transport by road to FSUE “VNIITFA” for dismantling;
6. Removal of RHSs at FSUE “VNIITFA” and loading of RHS packages onto trucks;
7. Transportation of packaged RHSs by road back from FSUE “VNIITFA” to FSUE VO “Izotop” and loading onto trains;
8. Transportation of packaged RHSs by rail to FSUE PA “Mayak”;
9. Processing of RHSs at FSUE PA “Mayak”.

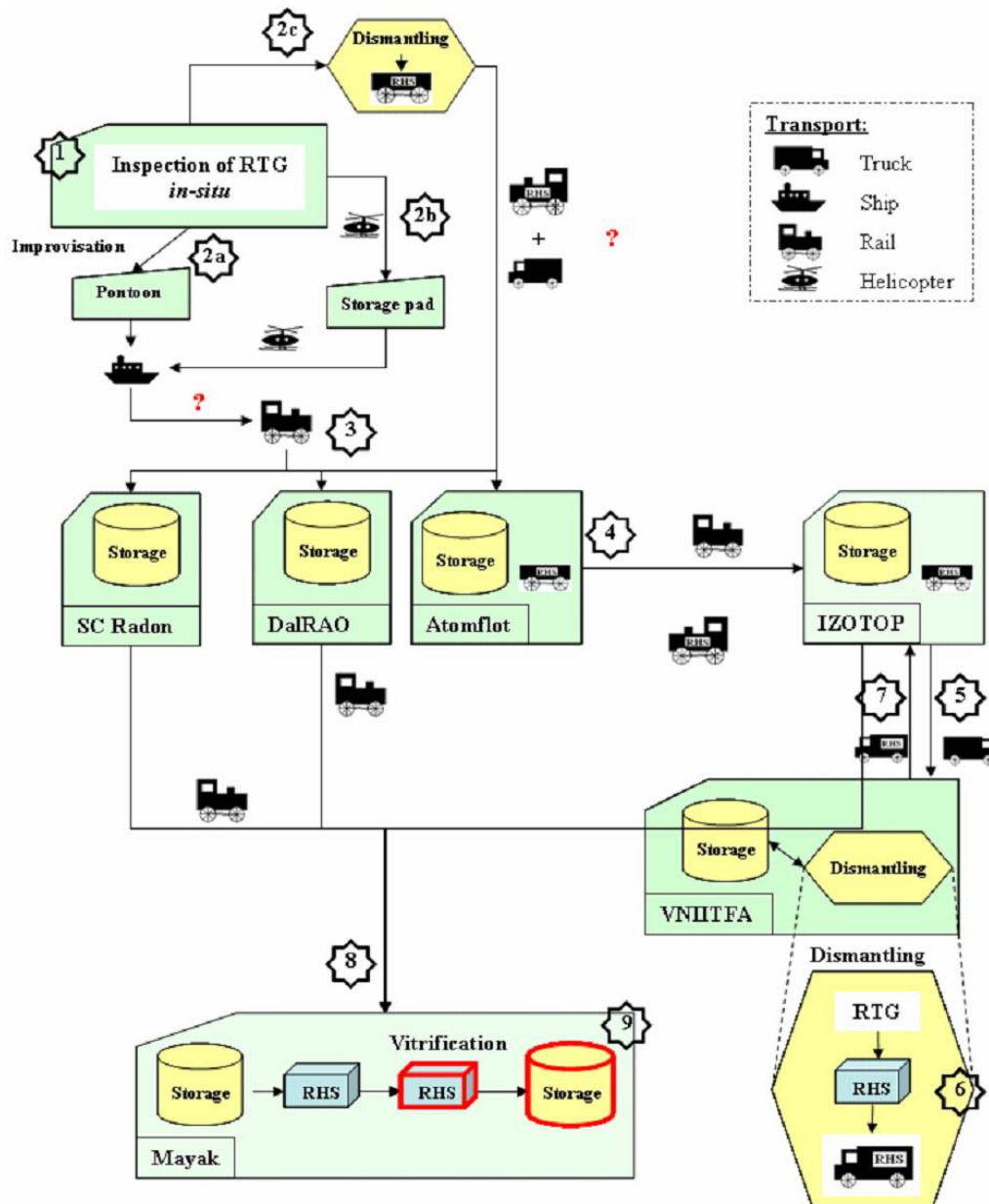


Fig 4) Nine steps in RTG decommissioning (flowchart developed within RTG Regulatory Support Project)

The risks associated with the nine steps listed above must be addressed for each RTG through:

- Preparation of a decommissioning plan;
- A safety analysis; and

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- An environmental impact assessment (EIA).

Each of these should be developed for each RTG before work starts on decommissioning. There will be many common features in the plans and assessments between different RTGs, but they should be tailored to take account of the specific characteristics of each RTG (location, history, condition, etc.) and the specifics of the decommissioning process for that RTG.

The physical form of the RHSs is intended to make it very unlikely that significant dispersion or leaking of activity could occur except under extreme conditions such as:

- Very severe impact or crushing;
- Very intense and/or prolonged fire;
- Long term immersion in water (e.g. in the sea); or
- Explosion (presumably a deliberate act).

The primary radiological threat is therefore direct exposure to radiation from the source in the event that shielding is removed or is no longer effective because of an accident or other disturbance.

The key operator actions to reduce the threats are therefore to:

- Manage the handling of intact RTGs and packaged RHSs so that doses to workers are kept low;
- Develop and apply effective procedures for managing RTGs found to be damaged or defective, to make them safe while minimizing the doses and risks to personnel;
- Apply technical and administrative safety measures to prevent (as far as possible) accidents or incidents that could damage RTGs or RHS packages at all stages of the decommissioning process;
- Apply technical and administrative security measures to prevent (as far as possible) unauthorized access to RTGs or RHSs (whether with malicious or misguided intent) at all stages of the decommissioning process;
- Develop, and apply if necessary, emergency measures to mitigate the consequences of any accidents or incidents, or breaches of security, that may occur.

These actions need to be systematically planned for all steps in the process and addressed in the decommissioning plan and safety and environmental assessments referred to above.

## REGULATORY PROJECT: TASK DEFINITION

Rostechnadzor has recognised that there is a need for upgrading the regulatory framework for the safe decommissioning and disposal of RTGs in the Russian Federation, taking account of the magnitude of the problem and the high hazard associated with the RTGs, as well as the lack of experience in this area.

The aim of the RTG RSP is therefore to upgrade the existing regulatory framework of the Russian Federation for the safe decommissioning and disposal of RTGs, with focus on the following priority areas:

1. Regulatory requirements and regulations, based on the Initial Threat Assessment
2. Requirements for data, safety assessment and quality assurance
3. Supervision over radiological safety and security including physical protection
4. Requirements for emergency preparedness and response, based on Environmental Impact Assessments made for each stage of RTG decommissioning

Other areas of interest include preparation of an inspection handbook, training and certification of personnel, on-going compliance monitoring and providing information for the public.

The first task is to clarify the roles and responsibilities of the different organizations involved – particularly operators and regulators – with respect to the safety and security of RTGs. The aim is to ensure that there is clear allocation of responsibilities, consistent coordination of regulatory control and compliance requirements, effective transfer of responsibility at each stage in the overall management process and transparency within the Russian regulatory regime. Indications are that there are currently gaps in these areas. This task needs to address both the roles and responsibilities relating to RTGs *in situ*, but also those relating to the other stages involved in decommissioning, including the transport of complete RTGs and of RHSs, the dismantling of RTGs, and the storage and ultimate disposal of RHSs.

In addition, Rostekhnadzor has responsibility for the regulation, control and supervision of all RTGs in Russian Federation, but the Defence Ministry is responsible for radiation and nuclear safety in military units. The Defence Ministry therefore has its own military nuclear regulatory body, and Rostekhnadzor often does not have access to military sites with RTGs.

In line with the Code of Conduct requirement for a national register of Category 1 and 2 sources, the operating organizations are developing – through a parallel industrial project – a database containing comprehensive information related to each RTG, e.g. location, description, key characteristics (including size of radioactive source) and associated potential hazards. The database will also provide an assessment of vulnerability specific to each RTG. Based on analysis of information from this database, Rostekhnadzor will consider whether the types of data held are adequate for all locations and RTGs, and thus identify gaps in information to be filled through the industrial project.

Another major task is to identify Russian Federation regulations relevant to the control of RTGs and to consider – taking into account international standards and recommendations and best practice in other countries – whether existing regulations need to be supplemented or modified and/or whether new regulations need to be developed. Again, this review will need to consider safety and security measures at the various stages of the RTG life-cycle: use, recovery, transport, decommissioning, storage and disposal. Regulations identified through this process as ‘missing’ or requiring modification (and which fall within the remit of Rostekhnadzor) will then be developed or modified.

## **APPLICATION AND ENFORCEMENT**

Once the basic regulatory infrastructure has been updated, it is proposed that further assistance will be provided in relation to some specific aspects of Rostekhnadzor’s role within the infrastructure.

Accordingly, support can be provided to Rostekhnadzor in developing an assessment capability, independent of the operators, sufficient to perform its two main assessment functions for the various activities involving RTGs, namely:

- developing regulatory guidance for operators on conducting assessments that satisfy regulatory requirements for each stage of the RTG life-cycle; and
- critically reviewing and evaluating safety and security assessments and EIAs submitted by operators in support of licensing and authorization applications at different stages, as a basis for regulatory decision-making.

Support is also being provided to adapt existing inspection procedures, or develop new ones, to be applied to the various stages of an RTG’s life cycle in accordance with the updated regulatory requirements. In addition an inspection handbook focusing on safety and security of RTGs is under development. This will aim to provide a system for tracking and recording inspection findings and monitoring of the risks. The audit trail would ensure compliance with regulation and help identify promptly any irregularities, or potential problems.

Finally, support is being provided for the development of regulatory guidance on requirements for emergency planning in relation to accidents or unauthorized actions involving RTGs at any stage of their life-cycle, and to improve the capabilities of Rostekhnadzor (and its TSOs) to fulfil their functions in the event of such an emergency.

## CONCLUSIONS

The Government of Norway has supported and continues to support the safe decommissioning of RTGs in Northwest Russia. This involves close cooperation with Russian authorities and other countries supporting the wider programme on RTG decommissioning. So far about a third of the RTGs in the region have been removed with Norwegian support, and without incidents.

Regulatory support is a vital adjunct to implementation of industrial projects in order to make the whole process safe and efficient for all concerned.

Furthermore, in the long term perspective, Rostechnadzor has continuing opportunities:

- to continue developing an effective and efficient modern regulatory process;
- to exchange information with other regulators and authorities in the Russian Federation, noting that EIA and safety assessment for many projects involve multi-disciplinary issues;
- to exchange information and experience with experts from other countries, and to apply that experience as is relevant to the Russian Federation.

In addition, it is clear that all participants gain from the practical experience of applying international standards and recommendations to specific projects and problems.

## REFERENCES:

1. IAEA (2004). Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna.
2. Contact Expert Group (2005). Workshop of the IAEA Contact Expert Group, CEG. Security and safety of radioactive sources: Decommissioning and replacement of radioisotope thermoelectric generators, 16-18 February 2005, Oslo. Organised by Norwegian Radiation Protection Authority / CEG secretariat. 2005. Østerås: Norwegian Radiation Protection Authority, 2005. CD-Rom.
3. NRPA (2004). Dismantling of RTGs on the Kola Peninsula, NRPA Bulletin 7-04, 25 March 2004
4. Standing WJF, Selnæs ØG, Sneve M, Finne IE, Hosseini A, Amundsen I, Strand P. Assessment of environmental, health and safety consequences of decommissioning radioisotope thermal generators (RTGs) in Northwest Russia. StrålevernRapport 2005:4. Østerås: Statens strålevern (Norwegian Radiation Protection Authority), 2005. [http://www.nrpa.no/dokumentarkiv/StralevernRapport4\\_05.pdf](http://www.nrpa.no/dokumentarkiv/StralevernRapport4_05.pdf)