

Decommissioning of Radioisotope Thermoelectric Generators of the Russian Federation

**Federal Agency of Atomic Energy
Office for SNF and RAW Management and Decommissioning of
Nuclear and Radiation Hazardous Facilities
Department for Decommissioning of the Facilities of
Nuclear Science and Industry**

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Decommissioning of Radioisotope Thermoelectric Generators (RTGs) of the Russian Federation is one of the high priority types of activity to reduce potential radiation hazard related to the sources of ionizing radiation of the Russian Federation.

RTGs as sources of ionizing radiation are mainly used for autonomous power supply of navigational aids at lighthouses. Specific feature of the RTG is that it poses a high potential radiological hazard in case integrity of its structure is damaged.

Radioactive strontium – 90 is used by these RTGs as a primary source of energy - heat, which is subsequently transformed into electric power by thermoelectric converters. The strontium – 90 is concentrated in one or several stainless steel capsules, i.e. radioisotope heat sources (RHSes). For instance, the initial radioactivity of strontium - 90 contained in the most powerful RTG of the IEU-1 type comes to 543000 Ci or $\sim 20 \times 10^{15}$ Bq

Despite the fact that most operating RTGs have been in service for a considerable time period (about 21 years on an average for an RTG), approaching the strontium - 90 half-life (~ 29 years), the total activity of the operating RTGs amounts to 916×10^{15} Bq, which is equivalent to the activity accumulated in almost 100 nuclear submarines. For comparison, activity accumulated in FSUE “SevRAO” in Andreeva Bay (Kola peninsular) is 130×10^{15} Bq.

Experience in operating RTGs has demonstrated high reliability of these devices and their efficiency in ensuring safe navigation. Still, potential environmental and radiation hazard of RTGs has grown recently due to unauthorized activity on disassembly of RTGs and the acts of vandalism, as well as possibility of the terrorist actions with the use of RTGs. All the above causes concerns of both the International community and of the Russian Federation.

In accordance with the existing regulatory documentation of the Russian Federation decommissioning of RTGs includes the following types of activities: inspection of the RTG technical state and dismantling of it; delivery of the RTG from the place of its dismantlement (installation) to the place of its loading onto the transportation unit and further transportation of the RTG for disassembly; disassembly of the RTG; transportation of the extracted radioisotope heat sources (RHSs) and the radiation shielding (RS) units to the manufacturing plants (Federal State Unitary Enterprise "Production Association "Mayak" and Joint Stock Company "ChMZ", respectively) for reprocessing or long-term storage; long-term storage of RHSs.

Besides, in the majority of cases work package on decommissioning of RTGs foresees their replacement with alternative power sources (APSeS).

1. Legal Basis of International Cooperation on Decommissioning of RTGs of the Russian Federation;

Decommissioning of RTGs of the Russian Federation is mainly carried out due to the International technical assistance rendered by the International community in the framework of the Agreement on Multi-Lateral Nuclear Environmental Program in the Russian Federation (MNEPR) dated May 21 2003, the Agreement between the United States of America and Russian Federation on Safe and Reliable Transportation, Storage and Destruction of Weapons and Prevention of Weapons Proliferation (Weapons Agreement) dated June 17 1992 (with consideration of the Attachment to the Agreement dated June 15-16 1999), as well as the RF US Intergovernmental Agreement on Cooperation in the Field of Nuclear Material Accounting, Control and Physical Protection (MPC&A Agreement) dated October 2 1999.

The Decree of the Government of the Russian Federation of May 18 2003 #288 stated that Minatom of Russia (now Rosatom) is the body authorized to coordinate the activity of Federal executive agencies to implement the MNEPR Agreement.

Respective Agreements are signed between Rosatom and a number of foreign investors working in the framework of the MNEPR Agreement in order to develop cooperation in the area of environmental protection and improvement of nuclear and radiation safety. An Agreement on cooperation in the sphere of nuclear materials accountancy, control and physical protection is concluded between the Ministry of Defense of the Russian Federation and the Department of Energy of the United States of America. Still it is important to note that of all the above Agreements it is only in the Agreement between Rosatom and MFA of the

Total :	731	261	212	7.51	519*	9.16	478
including:							
MoD of RF, including:	325	136	102	3.03	223*	4.91	185
Baltic Fleet Hydrographic Service	87	16	8	0.07	79	1.11	72
Northern Fleet Hydrographic Service	36	117	6	0.24	30	1.02	27
Pacific Fleet Hydrographic Service	148	0	70	2.12	78	2.17	75
12 HD	42	0	18	0.84	24	0.499	0
SMF	12	0	0		12	0.113	11
Rosmorrechflot (Sevmorput – Northern Sea Route)	317	125	24	1.10	293	4.22	293 (is specified)
Rosgidromet	11	0	8	0.11	3 (Antarctica)	0.028	0
FSUE PA “Mayak”	78		78				

Organizations of Rosatom perform the work on decommissioning and long-term storage of RTGs mainly due to financial resources of the USA, Norway, France, and Canada in order to reduce potential radiation hazard related to RTGs: FSUE “VNIITFA” (inspection, dismantlement and disassembly of RTGs), FSUE “DalRAO” (long-term storage of RTGs), “Isotope” Joint stock company, “Atomspetstrans” Joint stock company (transportation of RTGs and RHSs).

In 2001-2007 the organizations disposed of approximately 261 RTGs, and 212 dismantled RTGs were placed for long-term storage. Ratio of the presented figures shows that for the time being the number of RTGs, which have been disposed of, only slightly exceeds the number of RTGs placed for long-term storage.

3. Concept for Dismantlement and Disposal of RTGs in Different Regions of the Russian Federation

Concept for decommissioning of RTGs of the Russian Federation foresees the package of work starting with dismantling of RTGs, and finishing with disposal of them and placing of radioisotope heat sources (RHS) for long-term storage. This concept is valid for all RTGs of the Russian Federation.

Decommissioning of RTGs in the North-European and Baltic regions, as well as in the Northern Sea Route (Sevmorput) is carried out in accordance with this concept.

Decommissioning of RTGs located mainly in the Far East of Russia is currently carried out according to the following scheme – dismantlement of RTGs

and placing of them for long-term storage at FSUE “DalRAO”, i.e. the option with the delayed disposal. It is planned that this will be the option for decommissioning RTGs of PF of the Navy and of 12-th HD of MoD of RF (continental part of Sevmorput), and for partial decommissioning of RTGs of Rosmorrechflot (Sevmorput).

It is planned that by the end of 2010 storage site of FSUE “DalRAO” will be practically full, i.e. the number of RTGs located there will increase up to 250 pieces.

It is important to note that the final stage of lifetime of each RTG (including RTGs placed for long-term storage will be the stage of their disassembly and placing RHSes for long-term storage at FSUE PA “Mayak”.

Delay in decommissioning of RTGs is a temporary forced measure. It is necessary to make decommissioning of these RTGs a priority issue for the near future.

The accepted option of decommissioning of RTGs (complete cycle, or with delayed disposal) determines the cost of the RTG decommissioning.

The predicted cost for decommissioning of RTGs in different regions recalculated per one RTG is different. It is presented in Fig. 1.

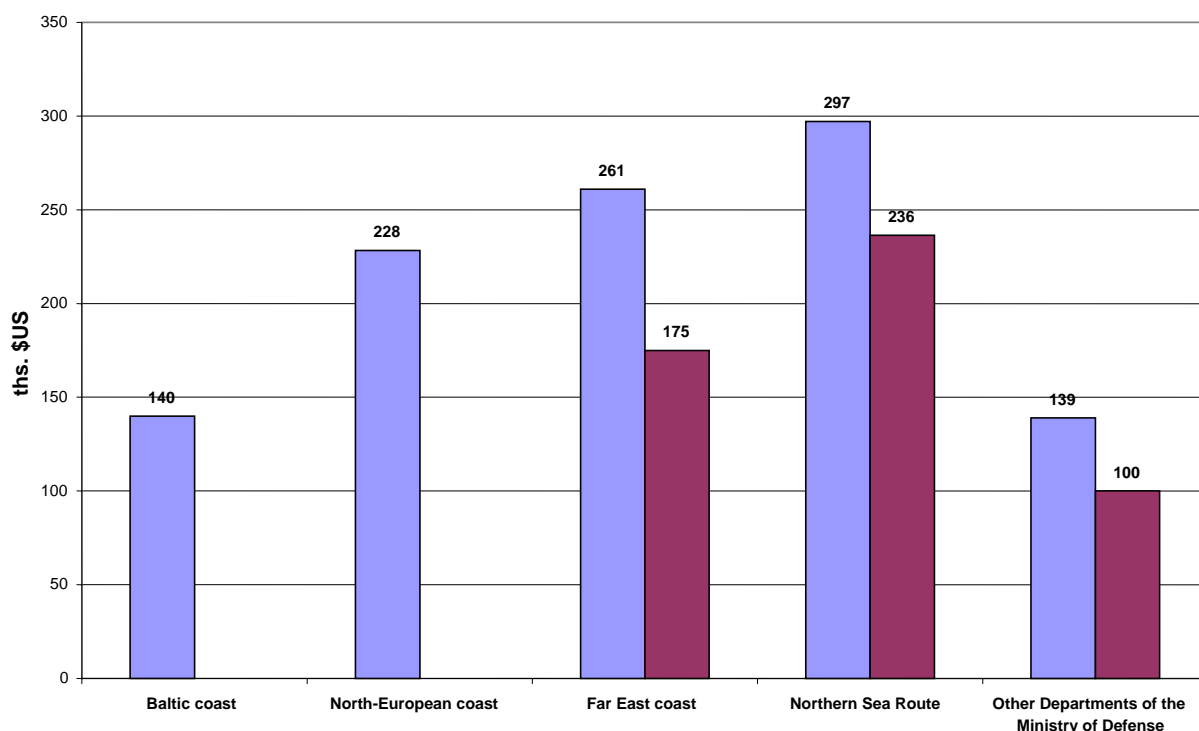


Fig. 1. Predicted Cost of RTGs Decommissioning in Regions Recalculated per one RTG

Blue columns – cost of an RTG decommissioning with disposal at FSUE “VNIITFA”

Purple columns - cost of an RTG decommissioning with the delayed stage of disposal

To dispose of RTGs according to the scheme with the delayed stage of disposal it will be necessary in the future to find approximately 30% of financial resources. Recovery in accordance with that recovery

It is shown in the diagram that in case of the option with the delayed disposal approximately 30% of financial resources necessary for disposal of RTGs are saved currently. Following this scheme disposal is postponed for uncertain time.

Additional expenses appear in case of the delayed disposal of RTGs, in particular – necessity to finance the work on operation of the RTG storage site at FSUE “DalRAO” – which is approximately 500 thousand USD per year. In 2008 the US allocated 141.4 thousand USD for operation of the storage site at FSUE “DalRAO”, the necessary amount of finance being approximately 500 thousand USD).

It is important to note that in spite of the fact that period for operation of the storage site is determined to be 50 years duration of keeping RTGs on the territory of FSUE “DalRAO” is mainly determined by the period of RHS operation. For different types of RTGs this period differs from 25 to 35 years. In accordance with the normative and regulatory documentation RTGs that were operated during the designed or extended lifetime are to be decommissioned for further disposal. Upon the completion of this period, RHS can be transferred into the category of radioactive wastes, and that is why its further stay at this storage site will become impossible. Decision on transfer of an RTG into the category of radioactive wastes is made jointly by the designer and manufacturer of the RTG and by the manufacturer of RHS. Besides, aging processes can start in RTGs with the expired term of operation. As a result, RTG will be classified as the damaged one, and the cost of its disposal will be approximately 10 times more expensive than of a non-damaged one.

Term of operation of RTGs that are currently placed at FSUE “DalRAO” is practically expired.

With consideration of the above the period of stay of RTGs at the storage site of FSUE “DalRAO” is to be shortened to the minimum. It is desirable to start disposal of these RTGs in the near future. The issue of financing the work to dispose of these RTGs has not been solved yet.

4. Improvement of infrastructure and establishing of facilities to dispose of RTGs

I have already noted that disposal of RTGs in line with the concept of delayed disposal postpones the stage of RTG disposal but does not exclude it.

The only existing hot cell for disassembly of RTGs is operated in FSUE “VNIITFA”. Therefore, total of radiation potential of the dismantled Russian RTGs are transported to Moscow to FSUE “VNIITFA”.

When the scheme for decommissioning of RTGs from the Far Eastern region was identified as the one with the delayed stage of disposal, it was planned that the “Set of facilities for storing and disposing of RTGs” including the hot cell in FSUE

“Mayak” (Facilities of FSUE PA “Mayak”) would be built to disassemble dismantled RTGs.

If we review the structure of expenses for decommissioning of the Far Eastern RTGs without the delayed stage of disposal (which is presented in Fig. 2) we can state that transportation expenses for disposal of 250 RTGs that will be located at FSUE “DalRAO” and also for recovery of 78 RTGs stored in FSUE PA “Mayak” will be 5.7 mln. USD. This amount is comparable with the scope of finance necessary to build Facilities of FSUE PA “Mayak” (4.8 mln. USD).

After the Facilities of FSUE PA “Mayak” are constructed it will become possible to transport RTGs from the Northern Sea Route (Sevmorput) to FSUE PA “Mayak” using a much shorter route. This will reduce transportation expenses for disposal of RTGs. Therefore, it is possible to state that construction of the Facilities of FSUE PA “Mayak” is economically beneficial.

Possibility of getting International technical assistance for construction of the Facilities of FSUE PA “Mayak” has been reviewed by Rosatom since 2004. Negotiations were carried on with Germany and France, but unfortunately there is still no financing of the work.

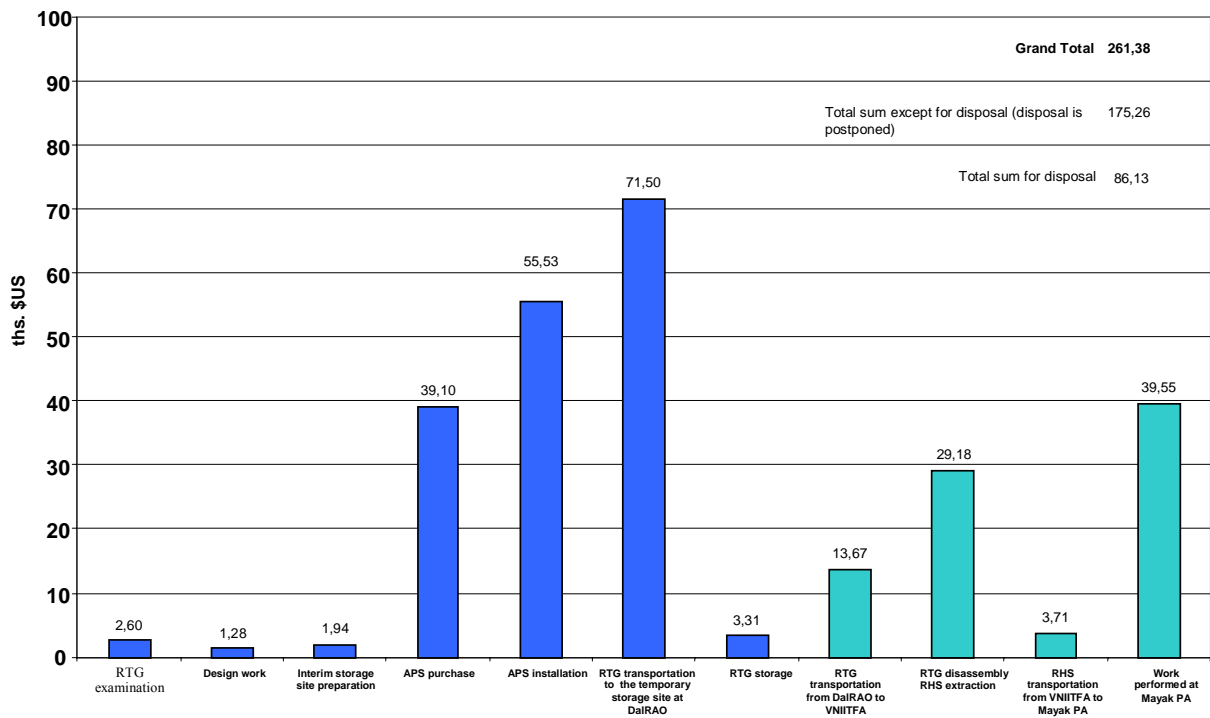


Fig. 2. Structure of Expenses for Decommissioning of RTGs Located on the Far Eastern Coast of Russia

If financing starts in 2008 the Facilities of FSUE PA “Mayak” can be put into operation at the end of 2011. Since then it will become possible to start disassembly of RTGs from “DalRAO”, FSUE PA “Mayak”, and Radon organizations.

Impossibility of constructing the Facilities of FSUE PA “Mayak” causes doubts as to expediency of the concept for decommissioning of RTGs from the Far

Ministry of Defense of RF	325	101	89	28	27				
Rosmorrech-flot	317	46	21	53	66	20	25	25	25
Rosgidromet	11								
FSUE PA “Mayak”	78								

369 of these RTGs are planned for decommissioning in 2008-2011

I would like to mention significant contribution of the US and Norwegian sides, as well Canadian and French sides cooperating in the framework of the US and Norwegian projects. It is due to financial support of these countries that Russian RTGs have already been decommissioned, and are planned for decommissioning.

6. Proposals to the Draft Minutes of the Seminar

1. Note significant contribution of the US and Norwegian sides to reducing potential radiation hazard by decommissioning of RTGs of the Russian Federation.
2. Continue the work to establish legal framework for International cooperation with the view of decommissioning of RTGs of the Russian Federation.
3. To review with the International community the issue of rendering International technical assistance to Russia:
 - 3.1. To construct the Set of facilities for storing and disposing of RTGs including the hot cell at FSUE PA “Mayak”.
 - 3.2. To develop the additional hot cell for disassembly of the damaged RTGs in FSUE “VNIITFA”;
 - 3.3. To maintain the work for storing RTGs in FSUE “DalRAO” and further disposal of them.