NRPA Bulletin

Statens strålevern

Dismantling of RTGs on the Kola Peninsula

In remote places along the Russian Arctic shoreline there are several hundred lighthouses powered by radioisotopic thermoelectric generators (RTGs). These generators contain highly radioactive Strontium-90 sources, which represent a local environmental hazard. Due to insufficient regulations for control and physical protection of the sources, they are readily accessible to intruders and the general public. A number of attempted thefts in recent years have demonstrated that these highly radioactive materials may also be available to terrorists seeking to utilise them.

An alternative to RTGs: A lighthouse fitted with a solar panel that generates electricity.
Photo: Office of the County Governor of Finnmark

Lighthouses powered by RTGs

Along the Arctic coast of Russia, in remote areas where electricity is not available, there are lighthouses powered by radioisotopic thermo-electric generators (RTGs) in which a radioactive strontium-90 source produces heat that powers a generator. The generator produces electricity to power the lamp in the lighthouse. RTGs are also used as power sources in radio beacons and weather stations and are found throughout Russia and other former Soviet countries. In 1993 there were close to 200 RTGs in about 130 lighthouses in the Murmansk and Arkhangelsk regions. The RTG-powered lighthouses on the Kola Peninsula are owned and operated by Mintrans and the Hydrographic Department of the Northern Fleet.

The safe removal of RTGs is of great concern to Norwegian authorities. Through the Norwegian Plan of Action for Nuclear Safety and the Environment, the Norwegian Ministry of Foreign Affairs currently finances two projects to replace RTGs with solar panels and pay for the waste disposal of removed RTGs. Both projects involve the Joint Norwegian-Russian Expert Group for Investigation of Radioactive Contamination (JNREG), and are led by the Office of the County Governor of Finnmark.

The Norwegian project financing RTG dismantling was initiated in 1995. In the five lighthouses that are closest to the Norwegian

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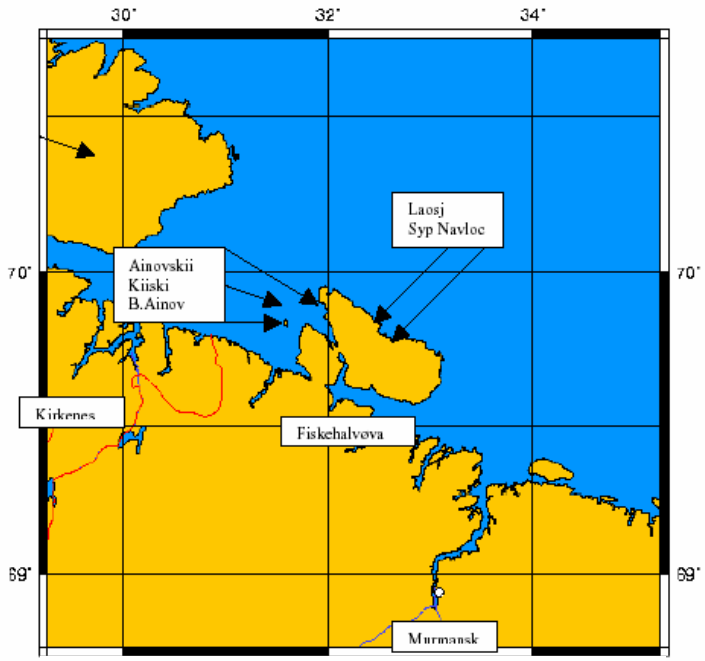


Map showing the locations of the five lighthouses where RTG power sources have been replaced by solar panels.

border, the RTG power source has been replaced with solar panels supplied by Norway. Altogether, 45 RTGs had been removed at the end of 2003 as a result of this project, and 23 additional RTGs are scheduled to be dismantled in 2004. It is also worth noting that RTGs are no longer being installed as power sources in lighthouses in Russia.

Technical information

A RTG is a radio-isotopic power device commonly used to provide electrical power to remote unmanned automatic systems, including navigational aids such as lighthouses and radio beacons located in desolate areas, satellites, and equipment used during deep-space missions.

Inside the RTG are one or several radioactive sources that decay, thereby generating heat which is transformed into electrical energy by a semiconductor thermoelectric converter. The RTGs used in Russian lighthouses utilise radioactive strontium, Sr-90, a beta-emitter with a half-life of 28.5 years.

The Sr-90 cores used in these RTGs consists of one or more compact, high-density solid fuel pellets, which are supposedly insoluble in both sea and fresh water. Together with its beta-emitting yttrium daughter, Y-90, the Sr-90 source provides ample heat, with a life span of between 10 and 20 years and a maximum temperature of about 500 °C. Both Sr-90 and Y-90 are pure beta emitters. However, x-rays are also emitted as bremsstrahlung when the beta radiation is absorbed in nearby materials.

The cores have activities ranging from 740 TBq (20 kCi) to 14800 TBq (400 kCi), depending on the type of RTG. Due to its long half-life and high level of radioactivity, the Sr-90 fuel pellets should be considered as a radiological hazard for a very long time.

Radiological hazards

As beta emitters, Sr-90 and Y-90 present two potential external radiation hazards, namely, the beta rays themselves and the radiation they produce in the source and adjacent materials.

Beta radiation is particle radiation with a limited range that does not penetrate far into exposed flesh, but may give serious and sometimes life threatening burns upon skin contact, depending on the strength of the source. X-rays, which are long-range, high-energy radiation, can penetrate almost any material. RTG cores are shielded in a special capsule to reduce the radiation emissions. Radiation on the surface of an unshielded core can reach 10 Sv/h, which can provide a lethal dose within half an hour of exposure.

Due to its chemical resemblance to calcium, Sr-90 is readily accumulated in bone tissue after ingestion or inhalation. In bone tissue, it has a long biological half-life and can cause necrosis and cancers of the bone and adjacent tissues.

Security and orphan sources

An inspection of the lighthouses in eastern Siberia by Russian nuclear specialists revealed that many lighthouses were in poor condition. The inspectors also did not find all the RTGs, which indicates that Russian authorities do not have a full overview of RTG locations. This reveals the

need for control of these sources and the importance of international cooperation for the regulation of radioactive materials.

Orphan sources (sources that are misplaced) are a radiation hazard in their own right, and they could also be utilized intentionally by terrorist organisations. A possible use could be a so-called "dirty bomb", where conventional explosives are used to disperse radioactive materials and thus pollute a specific area. The main purpose of such a device would be to cause public anxiety. Damage caused by the conventional explosives would be the most immediate effect of such a detonation, but the long-term effects might also be severe as resultant radioactive contamination could affect the area for years or even decades. The most severe tangible impacts of a dirty bomb are likely to be the social disruption caused by evacuation, the subsequent clean up of the contaminated area and associated economic costs.

Burns on the ground where the RTG had been left after being taken from the lighthouse in Kandalaksha (2001). Photo: Provided to the Office of the County Governor of Finnmark by Russian authorities regarding the handling of the RTG after the incident.

Recent incidents and thefts

There have been several break-ins and thefts from nuclear powered lighthouses in recent years, three of which have occurred in the Russian Barents region. Most Russian RTGs are unguarded against potential thieves or intruders, and lack basic security measures such as fences or warning signs. Additionally, some of these incidents demonstrate the need for a strengthening of legislation and regulatory documentation of the sources by Russian authorities.

For example, in 1999 a RTG was found at a bus stop in the town of Kingisepp in the then Leningrad region. It had been ravaged by non-ferrous metal looters. The radiation dose levels on the surface of the core were 10 Sv/h upon recovery.

In the summer of 2001, four people were hospitalised after receiving radioactive doses during an attempt to dismantle the lighthouse near Kandalaksha in Murmansk region. They had been trying to extract non-ferrous metal from the lighthouse in order to sell it later as scrap metal. They were not aware of the fact that there was a strong radiation source inside the lighthouse.

In February 2002, three shepherds from the village of Lia in the Tsalendzhikha region in West Georgia were exposed to high radiation levels after they stumbled upon a number of RTGs in a nearby forest. The RTGs were installed during the Soviet period.

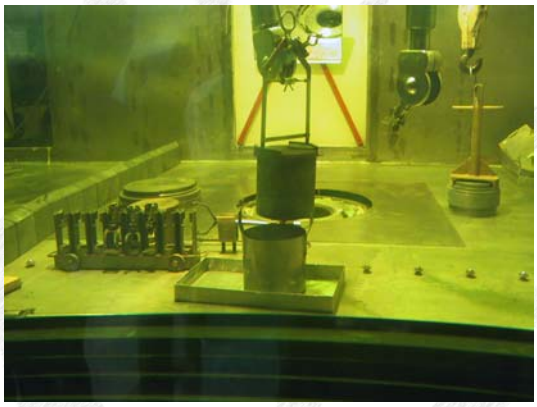
Russia also has about 100 RTG lighthouses in the Gulf of Finland region. On 28 March 2003, specialists from the Leningrad branch of the Radon Special Combine recovered an intact RTG core from the seafloor in the Gulf of Finland, 100 kilometres from the Finnish coast. Thieves had stolen the generator from a lighthouse, removed about 500 kg of stainless steel, aluminium and lead that shielded the radioactive core, and dumped the core onto the ice. The core melted through the ice and was found near the shore, at a depth of about 1 m. Since the core was intact, environmental experts do not believe that it caused any harm, apart from to its immediate surroundings.

In September 2003, service personnel from the Northern Fleet discovered an attempted theft at a nuclear powered lighthouse on the small island of Golets in the White Sea where the enclosure had been broken into. The lighthouse contained a particularly powerful RTG with six strontium cells.

On 12 November 2003, service personnel from the Northern Fleet discovered that the lighthouse at Olenia bay in the Kola Fjord was dismantled and everything besides the core had been stolen. The next day it was discovered that the same thing had happened on the Yuzhny Goryachnski Island, also in the Kola Fjord. In both cases the strontium sources were left nearby. A third break-in was discovered south of the entrance of Nerpa.

All of these incidents prove the importance of the safe removal of RTGs from Russia's Arctic coast. So far, the object of these break-ins has been to steal the valuable metal shielding. The thieves have not been interested in the RTG cores, or perhaps not even been aware of their existence. However, these thefts demonstrate how easily intruders can gain access to radioactive materials. It is also necessary to improve the Russian authorities' legislation and regulation of the sources.

A RTG with the enclosure and power supply. Photo: The Norwegian Radiation Protection Authority



Removal of a radioactive core at VNIITFA – The National Institute for Research on Technical Physics and Automatisation in Moscow. Photo: Office of the County Governor of Finnmark

Removal and waste management

Norwegian authorities are currently engaged in projects to replace RTGs with solar panels and provide for waste disposal of the removed RTGs. Solar panels function well, even during the winter, due to large battery capacities. In addition to this, the US Department of Energy are engaged in the removal of 38 RTGs stored at VNIITFA (the National Institute for Research on Technical Physics and Automatisation) and the manufacture of eight transportation containers. Moreover, the Russian authorities are currently assessing the environmental consequences of the removal and waste disposal of RTGs.

After specialists have removed the RTG from a lighthouse, the RTG is transported by sea or helicopter to a temporary storage at RTP-Atomflot in Murmansk. The RTG is then loaded onto a special train and sent to VNIITFA. In Moscow, the radioactive parts are removed and sent by rail in specially designed, tungsten shielded containers to the Mayak Production Association in the Chelyabinsk Region, where they are vitrified and stored as solid nuclear waste.

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