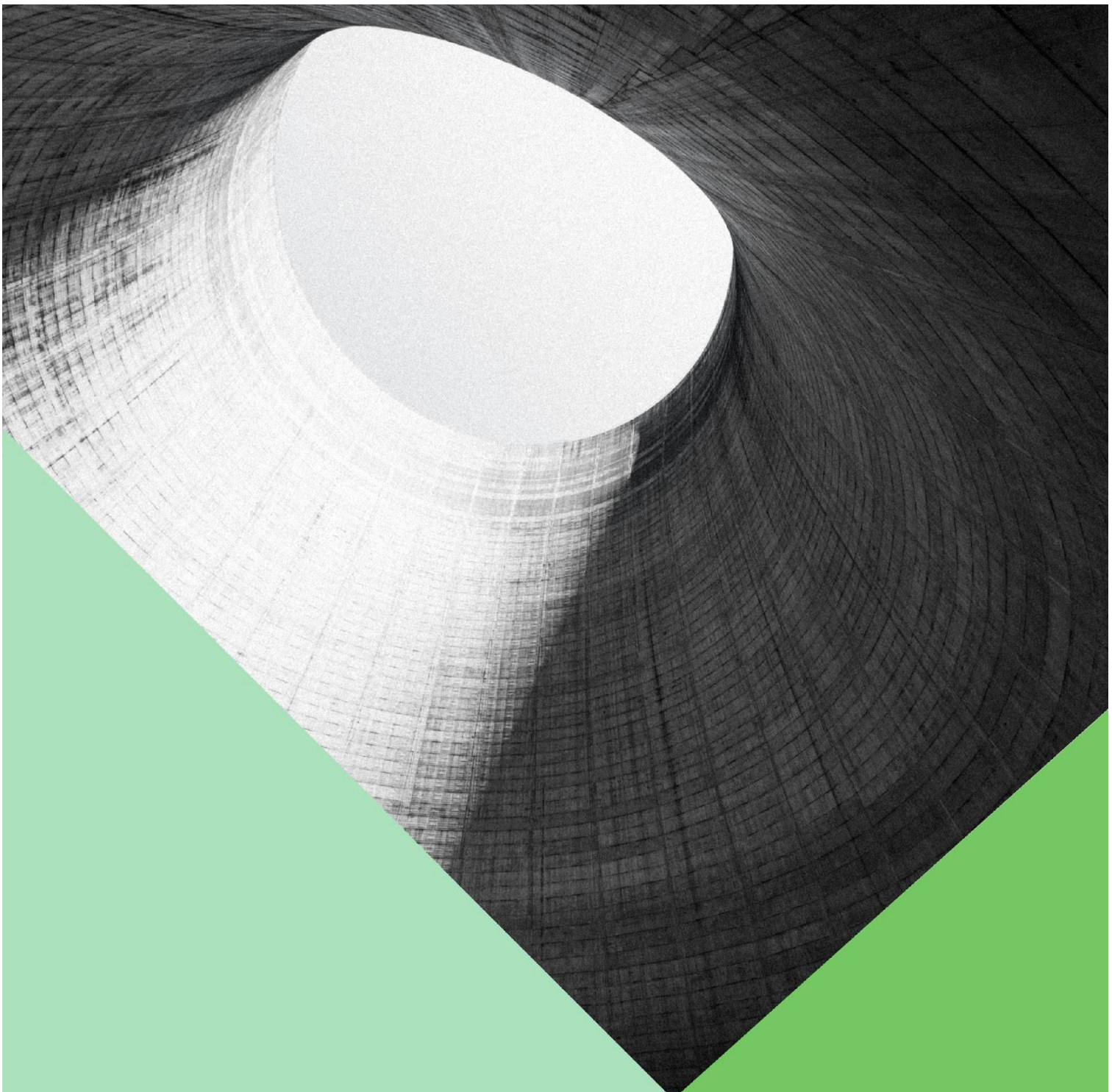

DECOMMISSIONING RUSSIA'S OLD NUCLEAR POWER REACTORS

STATUS UPDATE ON KEY PROCESSES

RUSSIAN SOCIAL-ECOLOGICAL UNION/FRIENDS OF THE EARTH RUSSIA,
KOLA ENVIRONMENTAL CENTER, ZA PRIRODU/FOR NATURE,
PUBLIC COUNCIL OF THE SOUTH COAST OF THE GULF OF FINLAND,
NATURVERNFORBUNDET/FRIENDS OF THE EARTH NORWAY

Decommissioning Russia's old nuclear power reactors

Status update on key processes 2020

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For more information, please contact the participating partners directly or refer to our reports, which can be found at the web site of Russian Social-Ecological Union (Friends of the Earth Russia): http://rusecounion.ru/eng/decomatom and at the web site of Naturvernforbundet (Friends of the Earth Norway): http://naturvernforbundet.no/decommissioning-reports

St.Petersburg, Sosnovy Bor, Chelyabinsk, Apatity/Murmansk, Oslo – April 2020

Decommissioning Russia's old nuclear power reactors

Status update on key processes 2020

Content

Introduction

In this report, we present status information on several issues related to decommissioning of nuclear power plants in Russia. All information is drawn from open and available sources. We have put the information together in a way that we hope is understandable and readable to everyone. Readers who wish for more details are directed to the sources presented in the texts.

At some point, all nuclear reactors come to the end of their lifetime. There are disagreements on when they should close, some claim that reactors should retire at their designed lifetime or even before. Some want to prolong the lifetime of the reactors. In Russia, the latter option has been chosen by the authorities and the nuclear industry for economic reasons. Still, all reactors will need to be closed at some point. It is reasonable to plan properly, so that reactors can be decommissioned in a safe and environmentally and socially friendly way, without unnecessary delays, with the spent nuclear fuel and radioactive waste taken proper care of, and with the interests of workers and the community in mind. In such a planning process, it is necessary to involve a broad range of stakeholders, to provide them with information, and actively solicit their opinions.

Russian and Norwegian environmentalists have cooperated since the late 1980s on several issues. In 2003, several Russian nuclear reactors reached their design life, and the organizations agreed to cooperate on transparency and participation in decommissioning planning.
The long-term goal of our cooperation is the safe and immediate decommissioning of the oldest nuclear reactors, and we are working to ensure that public participation advances preparations for the timely and safe decommissioning of the oldest nuclear reactors.

Has this goal come closer in recent years? There are both positive and negative aspects.

On the positive side, the interest and involvement of independent experts and experts from Rosatom, as well as regional and municipal deputies, have increased. Especially in the Leningrad Region, there has been an interest to have a say in decommission processes that surely have an impact on the people and nature in the region. Rosatom and Rostekhnadzor[1] have developed official documents regarding the decommissioning of old nuclear reactors. Also, we have managed to get more people interested in safety issues related to the nuclear industry and decommissioning.

On the negative side, there is no public involvement in decommissioning processes, and on top of that, the state is persecuting activists interested in these issuies. The laws on civil society participation are further tightened, which in its turn strengthens the monopoly of the federal authorities and the possibility of pressure on the public. Rosatom's plans for the transportation of radioactive waste and spent nuclear fuel to the Urals and Siberia are being implemented. The import of uranium hexafluoride from abroad is planned to continue in the coming years.

Reactor units have been closed at several nuclear power plants: Beloyarsk NPP, Novovoronezh NPP, Leningrad NPP, Bilibino NPP. However, decommission processes have started only at the Novovoronezh nuclear power plant and Leningrad nuclear power plant.

[1] Rosatom is a Russian state-owned corporation that builds and operates nuclear power plants in Russia and worldwide. Rostekhnadzor is the Federal Service for Environmental, Technological and Nuclear Supervision.

1. Current status of nuclear power in Russia

Daria Matveenkova (Public environmental movement Kola eco-center)

Summary

Russia has 38 power units at 11 active Nuclear Power Plants (NPPs) with a total installed capacity of ~31 GW. In table 1, all nuclear power reactors in Russia are listed and their operating status is shown.

More than 60% of all Russian reactors can be considered old - 24 of the nuclear units operate beyond their designed lifetime. Eight nuclear units will be closed in the coming 5 years (up to 2025). Eight power units are listed as shut down. Five units were stopped, and fuel was unloaded: Beloyarsk NPP units 1 and 2, Novovoronezh NPP units 1, 2 and 3. Three units were stopped, but fuel was not unloaded: Bilibinskaya NPP unit 1, Leningrad NPP units 1 and 2. Two nuclear power units are under construction.

The second reactor at the Leningrad nuclear power plant, a Chernobyl-type RBMK reactor, was closed in 2020. Two old reactors have been closed at the facility so far, their production replaced by two new VVER reactors.

Currently, the construction of the first and second units of Kursk NPP-2 is ongoing. The floating nuclear power plant Akademik Lomonosov was put into commercial operation on 22. May 2020.

Introduction

The article describes the state of Russia's nuclear power industry as of 2020, the age of nuclear reactors, plans for an extension, and building new energy units. It contains a table that shows the status of each nuclear power reactor in Russia, information about the type, location, and energy capacity as well as dates for commissioning and closure.

Background

As of March 2021, in Russia, there are 38 power units at 11 active Nuclear Power Plants (NPPs) with a total installed capacity of ~31 GW. 24 reactors operate on extended service life. 8 reactors will be closed in the coming years - until 2025. Eight power units are listed as shutting down. 2 nuclear power reactors are under construction (Kursk NPP).

The oldest operating power reactor is Novovoronezh NPP Reactor No. 4 VVER-440, commissioned on 28. December 1972 (47 years old).

The country ranks second, after France, among European countries in terms of nuclear generation capacity. Russia has a full range of nuclear power technologies, from uranium mining to electricity generation. The share of nuclear power in the total output of the united energy systems (UES) of Russia in 2020 was 19.71 %.

In 2013, the first version of the "Territorial Planning Scheme of the Russian Federation in the field of energy" was adopted; which (and with its subsequent editions) defines the construction of ten nuclear power plants with a total installed capacity of 21.4 GW until 2030.

The process was launched in 2019. In addition to the construction of medium- and large-capacity NPPs, one power unit with low-capacity reactors was built in Russia. A small-capacity floating nuclear power plant consisting of two power units with an electric capacity of 35 MW each was built and launched in 2019. Akademik Lomonosov, as the plant is called, will have its permanent location in the Chukotka region. See more on Akademik Lomonosov later in the article.

Russia's energy strategy for the period up to 2030 provides for an increase in electricity production at nuclear power plants to 356-437 TWh per year (2 times compared to the production in 2019).

On 10. June 2020, a new Energy Strategy of the Russian Federation for the period up to 2035 was approved. It replaced the Energy Strategy of Russia for the period up to 2030. It contains no new targets regarding nuclear energy development beyond the figures from the 2013 Territorial scheme. The strategy supposes the development of hydrogen energy, the development of gas transportation infrastructure, an increase in the innovative activity of fuel energy companies, as well as the development of low-power nuclear power plants. Such stations have a number of common characteristics - the installed electric capacity is up to 300 MW, the stations are based on modular solutions with the possibility of increasing capacity and placement in a small area without a developed power system.

Within the framework of increasing the efficiency of nuclear power, the share of nuclear power plants in the installed capacity of nuclear generation in the Russian Federation should reach by 2024 - 26 percent and by 2035 - 40 percent.

Decommissioning

In 2021-2026, a mass process of decommissioning of units that have reached their design life expectancy will begin. Seven reactors will be shut down and dismantled

- power unit 1 of the Kursk NPP, RBMK-1000 reactor (2021)
- power units 2, 3, 4 of Bilibino NPP, reactor EGP-12 (2022)
- power unit 2 of the Kursk NPP, RBMK-1000 reactor (2023)
- power unit 3 of the Leningrad NPP, RBMK-1000 reactor (2025)
- power unit 4 of the Leningrad NPP, RBMK-1000 reactor (2026)

This is a huge challenge - Russian nuclear engineers have succeeded in constructing nuclear power reactors, but the knowledge of dismantling them will have to be developed almost from scratch.

Dismantling works are funded by budget money and the decommissioning fund. Parts of the nuclear power tariff are deducted from this fund, but the deductions started too late and are too small to be enough for the decommissioning of all power units[2].

[2] For more information, see "How to pay? Financing decommissioning of nuclear power plants" (English, 2017) and "Состояние российского фонда по выводу из эксплуатации старых энергоблоков АЭС"/ "Status of Russia's

Russia's energy strategy for the period up to 2030 also declares an improvement of decommissioning technologies power units of nuclear power plants.

Foreign projects

Rosatom actively promotes foreign projects: while in Russia the state corporation is building three new power units (at Kursk NPP and Leningrad NPP), the portfolio of foreign contracts includes 36 power units. Works already are going on Akkuyu NPP in Turkey, Belarus NPP, El Dabaa NPP in Egypt, Hanhikivi 1 in Finland, NPP Kudankulam in India, Paks-2 NPP in Hungary, Ruppur NPP in Bangladesh, Xudabao NPP in China, Tianwan NPP in China.

All projects are at different stages of construction. For example, to 2020 in Turkey, concrete foundations were filled in for the first two blocks.

In November 2020, power unit No. 1 of the Belarus NPP delivered the first kilowatt-hours to the energy system of the republic. Finishing and installation works are being completed at power unit No. 2.

In Bangladesh, construction and installation work is currently being carried out on the construction site of the NPP.

In Egypt, the design of the NPP and preparation of documentation for obtaining the so-called nuclear license by the Egyptian atomic supervision authority are continuing.

In September 2020, Rosatom created a digital configuration management system at the basic design for the Hanhikivi-1 NPP in Finland.

To date, over 20 research reactors have been built abroad using Russian technology[3].

Changes at nuclear power plants in 2020

More detailed changes at Russian nuclear power plants are shown in the table. Reactors are marked in different colors for easy identification of their status.

Symbols in the table:

Red: power units operated with extended service life beyond designed life-time
Black: power units operated within the unexpired design service life
Green: the power unit was stopped, and fuel unloaded
Purple: the power unit is finally shut down, the fuel has not been unloaded, and the unit is operating in a mode without generation
Blue: power unit under construction or planned

decommissioning fund" (Russian and English, 2006). Available here: https://naturvernforbundet.no/decommissioning-reports/

[3] Rosatom - projects abroad http://www.rosatominternational.com/projects-abroad

Table 1: Nuclear power plants (NPPs) in Russia

Name of Power Unit	*Satellite cities of nuclear power plants, regional centers (with distances)*	*Type of power unit*	*Power Gross MW*	*Generation*	*Year of commissioning*	*End of designed lifetime*	*Planned end*
Akademik Lomonosov, floating	Pevek, 0 км Anadyr, 610 км						
NPP -1		KLT-40S	35	2	2019	2059	
A.Lomonosov 2		KLT-40S	35	2	2019	2059	
Balakovo 1	Balakovo -12.5 km	VVER-1000	1000	2	1985	2015	2045
Balakovo 2	Saratov - 145 km	VVER-1000	1000	2	1987	2017	2048
Balakovo 3		VVER-1000	1000	2	1988	2018	2048
Balakovo 4		VVER-1000	1000	2	1993	2023	2053
Beloyarsk 1	Zarechnny -3 km	AMB-100	100	1	1964	1981	End 1988
Beloyarsk 2	Ekaterinburg - 15 km	AMB-200	200	1	1967	1989	End 1989
Beloyarsk 3		BN-600	600	2	1980	2010	2025
Beloyarsk 4		BN-800	880		2015	2075	
Bilibino 1	Bilibino - 4 km	EGP-6	12	1	1974	2004	End 2019 (14.01)
Bilibino 2	Anadyr - 610 km	EGP-6	12	1	1974	2004	2022
Bilibino 3		EGP-6	12	1	1975	2005	2022
Bilibino 4		EGP-6	12	1	1976	2006	2022
Kalinin 1	Udomlya - 4 km	VVER-1000	1000	2	1984	2014	2044
Kalinin 2	Tver - 125 km	VVER-1000	1000	2	1986	2016	2047
Kalinin 3		VVER-1000	1000	2	2004	2034	2065
Kalinin 4		VVER-1000	1000	2	2011	2041	2073
Kola 1	Polyarnye Zori 11	VVER-440/230	440	1	1973	2003	2033
Kola 2	km	VVER-440/230	440	1	1974	2004	2034
Kola 3	Murmansk 170 km	VVER-440/213	440	2	1981	2011	2036
Kola 4		VVER-440/213	440	2	1984	2014	2039
Kursk 1	Kurchatov 4 km	RBMK-1000	1000	1	1976	2006	2021
Kursk 2	Kursk 40 km	RBMK-1000	1000	1	1979	2009	2023
Kursk 3		RBMK-1000	1000	2	1983	2013	2028
Kursk 4		RBMK-1000	1000	2	1985	2015	2030
Kursk 5		VVER TOI	1255	3+	2025		
Kursk 6		VVER TOI	1255	3+	2026		
Kursk 7 (plan)		VVER TOI	1255	3+	2026		
Kursk 8 (plan)		VVER TOI	1255	3+	2029		
Leningrad 1	Sosnovy Bor 3,5	RBMK-1000	1000	1	1973	2003	End 2018 (21.12)
Leningrad 2	km	RBMK-1000	1000	1	1975	2005	2020 (12.12)
Leningrad 3	Saint Petersburg	RBMK-1000	1000	2	1980	2009	2025 (31.01)
Leningrad 4	35 km	RBMK-1000	1000	2	1981	2011	2026 (26.12)
Leningrad 5		VVER-1200	1200	3+	2018	2068	2078
Leningrad 6		VVER-1200	1200	3+	2020	2070	
Leningrad 7		VVER-1200	1200	3+	2026		
Leningrad 8		VVER-1200	1200	3+	2027		
Novovoronezh 1	Novovoronezh 3.5	VVVER-440/210	417	1	1964	1984	End 1984
Novovoronezh 2	km	VVER-440/365	417	1	1969	1989	End. 1990
Novovoronezh 3	Voronezh 45 km	VVER-440/179	417	1	1971	2001	End. 2016
Novovoronezh 4		VVER-440/179	417	1	1972	2002	2032
Novovoronezh 5		VVER-1000-187	1000	2	1980	2010	2036
Novovoronezh 6		VVER-1200	1114	3+	2016	2077	
Novovoronesh 7		VVER -1200	1114	3+	2019	2078	
Rostov 1	Volgodonsk - 11	VVER-1000	1000	2	2001	2031	2062
Rostov 2	km	VVER-1000	1000	2	2010	2040	2071
Rostov 3	Rostov-on-Don -	VVER-1000	1000	2	2014	2044	2075
Rostov 4	250 km	VVER-1000	1000	2	2018	2048	2079

Smolensk 1	Desnogorsk 3 km	RBMK-1000	1000	2	1982	2012	2027
Smolensk 2	Smolensk 150 km	RBMK-1000	1000	2	1985	2015	2029
Smolensk 3		RBMK-1000	1000	3	1990	2020	2034
Smolensk 4 (plan)		VVER-1300/510	1255		2027		

Kola NPP

Every year, planned, repair and modernization works are carried out at the 4 VVER-440 power units of the Kola NPP that have developed the design resource to continue their operation.

The Kola Nuclear Power Plant is working on a project to use excess power generation capacity to produce hydrogen and then use it as fuel for trains, cars and other vehicles with hydrogen internal combustion engines.

Leningrad NPP

On 10. November 2020, Unit 2 with RBMK-1000 reactor was shut down after 45 years of operation[4]. This was the second reactor to close, two more are left.

In October 2020, the Leningrad NPP received permission from Rostekhnadzor to raise the capacity of power unit No. 6 with the VVER-1200 reactor to a capacity of 35-40%. This allowed the unit's turbo generator to be connected to the grid and the transmission of electricity to a single power system. It is expected to reach its full capacity in early 2021[5].

On 19. October 2020, a test run of the turbine of innovative power unit No. 6 with a VVER-1200 reactor was performed at LNPP. Power units №7and 8 are planned to be constructed in 2026 and 2027.

Kursk NPP

The construction of the Kursk NPP-2 continues. It will replace two RBMK units of Kursk NPP on the same capacity - 2510 MW, VVER reactors type. In 2020, work was done to form the sand base for auxiliary buildings. There are also plans to build the main buildings of the power units. Construction is scheduled to be completed in 2024, and commissioning should occur within three years thereafter[6].

On 8.July 2020 the construction of the cooling tower, which will be the highest cooling tower in Russia, began at Unit 1 of the Kursk NPP-2 (Kursk 5 in the table). The heat removal capacity will be increased by 22%, which will make it possible to operate without reducing generation during the hot summer months.

Smolensk NPP

26.June 2020 Rosatom signed a decree on the construction of two new power units at the Smolensk NPP. The projects are included in the "General Scheme of Location of Electric Power Facilities until 2035," which was approved by the Russian government.

[4] The second power unit of Leningrad NPP was stopped https://neftegaz.ru/news/nuclear/638814-smena-prishla-posle-45-let-uspeshnoy-raboty-ostanovlen-2-y-energoblok-leningradskoy-aes/

[5] A new unit at the Leningrad NPP will start generating electricity in 2020 https://tass.ru/ekonomika/9705003

[6] Construction of the Kursk nuclear power plant will be completed in 2024 https://iz.ru/957158/2019-12-22/stroitelstvo-kurskoi-aes-2-zavershitsia-v-2024-godu

These will be VVER units that are similar to those being constructed at Kursk NPP-2. They will be built six kilometers from the operating plant and will replace the RBMK reactors (on the same capacity in the long term) that will reach the end of their service life in the next decade[7].

Beloyarsk NPP

At the Beloyarsk NPP, they plan to build a new power generating unit No. 5 with a BN-1200 reactor to replace power generating unit BN-600 (unit 3). The project is under development, construction is to begin in 2030 and the plant is to be commissioned in 2050[8].

Akademik Lomonosov floating nuclear power plant

Construction of the first floating nuclear power plant Akademik Lomonosov began at the Baltic Shipyard in 2008. Akademik Lomonosov was put into commercial operation on 22. May 2020. Now it provides electricity for 50% of the needs of the Chaun-Bilibino power grid in one year[9]. The service life of the power units of the FNPP Akademik Lomonosov is 40 years.

At the end of 2015, Rosatom announced plans to build at least seven floating nuclear power plants. The state corporation is already working on the second generation of floating nuclear power plants. There plans to optimize the floating power unit by making it smaller and more powerful. It is assumed that it will be equipped with two RITM-200M reactors with a total capacity of 100 MW. Rosatom plans to export the technology and is in talks with potential buyers from Latin America, Africa, and Asia.

In 2020, the project of an optimized floating nuclear power unit was presented by Atomenergomash at the "Arctic: Present and Future" international forum held in St. Petersburg.

Conclusion

The nuclear industry in Russia can be viewed as obsolete: most nuclear reactors are more than 40 years old. Those plants operate on extended operating permits, sometimes several times. In the next few years (2021-2026), a massive process of decommissioning units that have reached their design life expectancy will begin in Russia. Seven nuclear units will be shut down and dismantled. It means a search for funds for decommissioning, dealing with environmental, social aspects of decommissioning of power units (personnel retraining, providing employment, etc.).

Experts worry about the lack of money for decommissioning, and it is clear that a large share must be taken from budget sources. It is noteworthy that the nuclear industry has not yet come up with reliable technology for the preservation of spent nuclear fuel, now the waste is taken to special temporary storage facilities.

[7] Construction of the Smolensk NPP-2 is included in the general scheme of Rosatom
https://gtrksmolensk.ru/news/stroitelstvo-smolenskoj-aes-2-vklyucheno-v-general
[8] The Beloyarsk NPP is ready to start construction of power unit 5 in 2030
https://tass.ru/ural-news/9577155
[9] Russia puts the world's first floating nuclear power plant into commercial operation
https://tass.ru/ekonomika/8540307

The nuclear industry in Russia continues to develop actively. Three new power units are being prepared for replacement; five new reactors are at the planning stage. 35 power units of nuclear power plants are being built abroad (in various stages of implementation).

Photo: ПиМ - Природа и молодежь/ PiM - Priroda i Molodezh which means "Nature and Youth" (old photo)

2. SOSnovy Bor and the nuclear cluster of the southern shore of the Gulf of Finland

Oleg Bodrov (physicist, ecologist, chair of the Public Council of the South Shore of the Gulf of Finland, an interregional social and environmental movement of the Leningrad Region and St. Petersburg)

Summary

The article analyzes the sixty-year history of the development and evolution of views on the socio-ecological and radiation safety of the nuclear cluster on the southern shore of the Gulf of Finland in the city of Sosnovy Bor.

It is shown that a nuclear cluster is entering a dangerous stage of its life cycle, when new and old nuclear power units will be operated simultaneously over the next 10 years.
The mechanisms of making political decisions on the construction, commissioning and decommissioning of nuclear power units are described. These decisions do not take into account the complex of impact of all nuclear hazardous enterprises on the environment and their possible impact on each other. The ability of ecosystems to accept additional anthropogenic loads while maintaining the mechanisms of reproduction of healthy habitats is also not evaluated.

The main challenges and specific recommendations for decision-makers to take steps to promote the sustainable development of this region are outlined.

Introduction

The nuclear cluster in the Russian city of Sosnovy Bor is located at the southern shore of the Gulf of Finland, 70 km from Estonia, 100 km from Finland, and only 35 km from St. Petersburg with its 5 million residents.

It was formed over 60 years on the territory where the indigenous population used to live in harmony with the environment and traditionally engaged in fishing. After World War II and until the early 2000s, four fish processing plants operated here, employing thousands of people. Products were supplied not only to neighboring regions, but also for export.

Currently, the nuclear cluster includes the following enterprises of Rosatom:

- Leningrad Nuclear Power Plant (LNPP), the largest one in Russia and the Baltic region with a temporary Spent Nuclear Fuel Storage facility (SNFS) and a Complex for Processing of Radioactive Waste (CPRW) LNPP.
- A.P. Alexandrov Research Institute of Technological (ARIT) - a unique site for testing nuclear power units for nuclear submarines
- Ecomet-S - Europe's largest plant for processing radioactive metal waste
- Federal Environmental Operator (FEO), a branch in the Northwest Territorial District, is a temporary storage facility for medium- and low-level radioactive waste (formerly the Lenspetskombinat Radon).

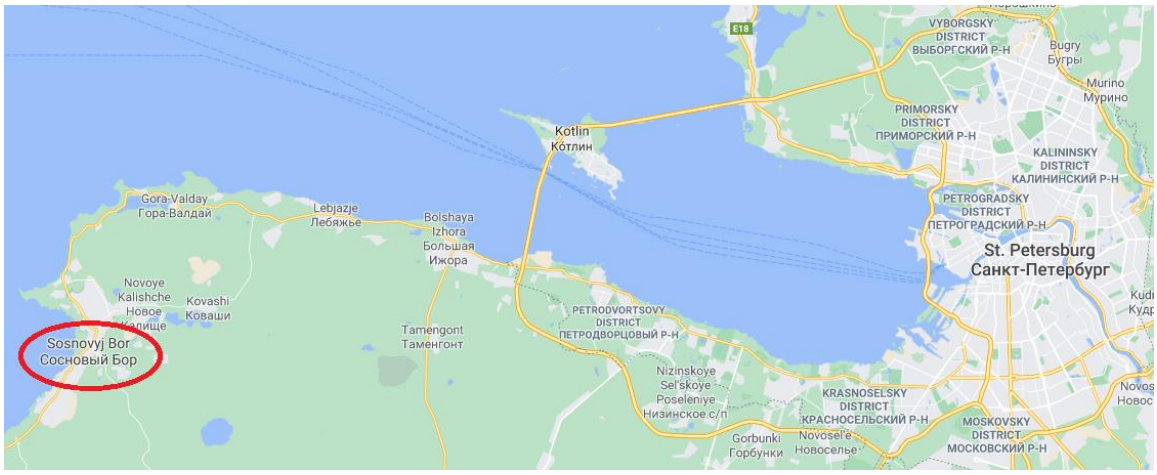

Figure 1. Sosnovy Bor single nuclear industry city on the South Coast of the Gulf of Finland of the Baltic Sea.

A new stage of nuclear cluster development

At present, the nuclear cluster is entering a new stage of its life cycle. A "generational change" is taking place. On the one hand, decisions are being made to build new nuclear-hazardous facilities, and on the other hand, it is necessary to decommission those of them that have expired their designed lifetime. From these reactors, it is necessary to safely isolate spent nuclear fuel and radioactive waste (RW) from the environment.

This is a systemic challenge that requires an assessment of the environmental impact not only of each individual nuclear installation, but also of the entire set of nuclear cluster facilities, taking into account possible synergistic effects, as well as the impact of individual nuclear facilities on each other.

This is a complex task that has economic, social, environmental, and moral dimensions. Its solution will have long-term consequences affecting the interests of many future generations, not only on the Russian coast of the Finnish Gulf but in the whole Baltic Sea Region.

In order to develop a balanced strategy of action to address it, it is necessary to involve representatives of all stakeholders, i.e., society, government, and business. It is essential that their interaction is based on democratic principles and take into account the social, environmental, and historical development experience of the area.

Sosnovy Bor – a city of nuclear workers

Sosnovy Bor, with its 68 000 residents, is one of 20 nuclear single industry cities (monocities) in Russia closed for access of foreign citizens. It is located 3.5 km away from the nuclear cluster. Russian State Corporation Rosatom is the main employer, giving jobs to about 10 000 citizens. The social infrastructure of the city (schools, hospitals, cultural facilities) depends on the efficiency of nuclear enterprises.

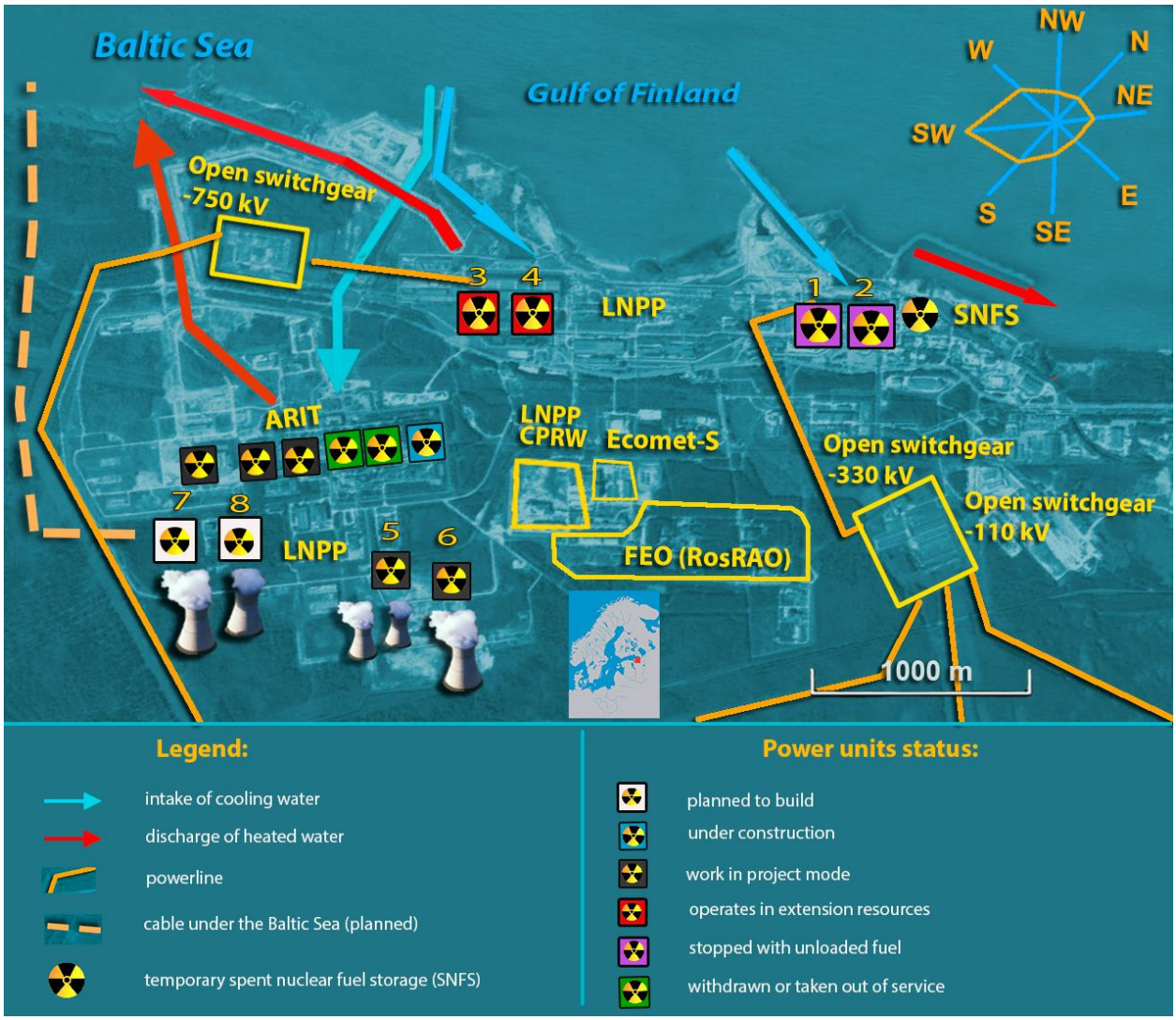

Figure 2. Nuclear cluster on the southern shore of the Gulf of Finland consisting of:

- *Leningrad NPP (LNPP) with a Complex of Processing Radioactive Waste (LNPP CPRW) and a temporary Spent Nuclear Fuel Storage (SNFS) facility.*
- *A.P. Alexandrov Research Institute of Technology (ARIT), Russian abbreviation NITI.*
- *Federal Environmental Operator (FEO, formerly RosRAO), a temporary storage facility for low- and intermediate-level waste.*
- *Ecomet-S plant for processing of radioactive metal waste.*

Leningrad nuclear power plant (LNPP)

LNPP is the largest nuclear power plant in Russia and the drainage basin of the Baltic Sea. It is the most powerful source of anthropogenic impact on the environment on the Southern Shore of the Gulf of Finland.

Currently, there are four power generating units with a total electric capacity of 4400 MW in operation: two RBMK-1000 (2×1,000 MW) and two VVER-1200 (2×1,200 MW) reactors

The two oldest RBMK-1000 units were finally shut down in 2018 and 2020, after 45 years of operation, and are scheduled to be decommissioned by 2053. Units 3 and 4 are scheduled for final shutdown in 2025 and 2026 and will be decommissioned to "brownfield" status by the end of 2059.

A decommissioning program for Power Unit 1 at Leningrad NPP has been developed and approved. After the final shutdown of the power unit and prior to the final removal of spent nuclear fuel from the reactor (up to 5 years), the annual cost of its operation without power generation will be more than 2.6 billion rubles, and the development of the project documentation for the decommissioning is estimated at 0.8 billion rubles. The expected cost of decommissioning the first and second power units of LNPP, taking into account the costs of radioactive waste disposal, but without the costs of final isolation for spent nuclear fuel, will amount to 64 billion rubles.

The LNPP Complex for Processing Radioactive Waste (LNPP CPRW) was built on the territory of the LNPP and it is intended for:

- Incineration of hundreds of tons per year of combustible radioactive waste.
- Processing up to 1,000 m^3 per year of solid radioactive waste.
- Reception, processing, and conditioning of Liquid Radioactive Waste (LRW).

More than 20 thousand m^3 of the bituminous compound and more than 30 thousand m^3 of LRW have been accumulated at the LNPP CPRW.

The LNPP temporary Spent Fuel Storage Facility (SNFSF) houses approximately 40.000 spent fuel assemblies (5.000 tons). The fuel assemblies are cooled in special pools located only 90 meters away from the Baltic Sea. The spent nuclear fuel (SNF) contains about 35 tons of super-toxic ^{239}Pu with a half-life of 24,000 years.

There are no environmentally and economically acceptable technologies for its processing or disposal. Transportation of SNF from decommissioned LNPP reactors to a temporary (up to 50 years) national dry storage facility at the Mining-Chemical Combine in the closed administrative-territorial entity (Russian abbreviation ZATO) Zheleznogorsk of Krasnoyarsk Territory has begun. These transports are expected to be completed after 2031.

New LNPP power unit - irregularities in the development process

In the development process for the construction of new power units with VVER-1200 reactors in Sosnovy Bor, manipulation of the public environmental review system excluded local organizations from the possibility to make their environmental reviews of the project documentation. While the administration of Sosnovy Bor in 2007 registered two public reviews by the Moscow based organizations (the so-called governmental non-governmental organizations, GoNGO) "Environmental Movement of Real Action[10] and "Ecosphere"[11], the local Sosnovy Bor's public environmental charity organization "Green World" was denied this opportunity.

The results of both Moscow public examinations were similar: "No slightest impact."[12] These results were later challenged by a group of nuclear experts from Sosnovy Bor led by Anatoly

[10] NGO Environmental Movement of Concrete Cases - All-Russian Social Movement (Rus.), http://greenlight-int.org/files/main_page/brochure_edkd.pdf

[11] Ecosphere – an autonomous non-profit organization (Rus.), https://ecosfera-tmb.ru/

[12] V. Grachev, "Not the slightest impact", Mayak municipal newspaper, Sosnovy Bor, Leningrad Region, July 11, 2007 (Rus.), https://mayaksbor.ru/news/atomgrad/ni_maleyshego_vozdeystviya/

Eperin, Dr. of Engineering, former director of the LNPP.[13] The experts proposed to eliminate critical deficiencies in order to exclude the risk of emergencies in winter, in which during normal

operation the new power units could cause an emergency shutdown of the old ones. These proposals were not accepted by Rosatom State Corporation.

Infringements during construction of the LNPP power unit with VVER-1200 reactors
In March 2016, there was published an appeal [14] and a video message [15] of a "Veteran of Rosatom State Corporation", the builder of the LNPP involved in the construction of the VVER-1200 reactors, who reported numerous manipulations and violations that made it impossible to ensure the design safety characteristics of the power unit's equipment. An inspection by the nuclear safety regulator (Rostechnadzor) did not refute the facts of the violations and, in the author's opinion, it was conducted formally[16].

Thus, we can conclude that LNPP Unit 5 with a VVER-1200 reactor does not have the required design safety characteristics.

A.P. Alexandrov Research Institute of Technology (ARIT)

For more than 55 years, the Institute has conducted experiments and tests of 5 experimental nuclear power facilities for submarines[17].

In the 2000s, one of these nuclear power facility was commissioned, while two nuclear power facilities were finally shut down and decommissioned[18,19,20]. The spent cores appear to have been removed for disposal[21].

[13] Expert opinion of nuclear industry veterans on the project of the Leningrad NPP-2 under construction, June 6, 2013, (Rus.), http://www.greenworld.org.ru/laes2_gradir_zak6613

[14] An open appeal by Viktor Aleinikov, "Veteran of Atomic Energy and Industry" of Russia (Rus.), 03.03.2016, http://www.greenworld.org.ru/?q=laes2_aleinikov

[15] Video message from Viktor Aleinikov, "Veteran of Atomic Energy and Industry" of Russia (Rus.) 01.03.2016 https://www.youtube.com/watch?v=I1jS8vabFik&t=438s

[16] Video Message from Viktor Aleinikov, LNPP-2 Builder "Leningradskaya NPP-2 is still dangerous" (Rus.), 2017, https://www.youtube.com/watch?v=kB_9VpacOYU

[17] Aleksandrov Research Institute of Technology 40 years. – SPb., LLC Research Center "Morintech", 2002 – 360c.

[18] Order of the Federal Service for Environmental, Technological and Nuclear Supervision of August 14, 2009 N 708 "On approval of the conclusion of the expert commission of the state environmental examination of materials substantiating a license to carry out activities in the field of atomic energy use" Decommissioning of a complex with an experimental nuclear reactor (stand- prototype VAU-6s nuclear power reactor of the ship)", Federal State Unitary Enterprise" Alexandrov Research Institute of Technology (Rus.)

[19] Order of the Federal Service for Environmental, Technological and Nuclear Supervision of June 3, 2011 No. 278 "On Approval of the Annual Report on the Activities of the Federal Service for Environmental, Technological and Nuclear Supervision in 2010" (Rus.) http://www.garant.ru/products/ipo/prime/doc/2074801/#ixzz6dODFLWdi

[20] Order of the Federal Service for Environmental, Technological and Nuclear Supervision of October 9, 2009 N 855 "On approval of the conclusion of the expert commission of the state environmental examination of materials justifying the license to carry out activities in the field of atomic energy use" Decommissioning of the prototype stand of the KM-1 nuclear power reactor" Federal State Unitary Enterprise "Alexandrov Research Institute of Technology (Rus.) Sosnovy Bor, Leningrad Region"

[21] Order of the Federal Service for Supervision in the Sphere of Transport No. GK-14-fs dated January 19, 2011 "On the granting of a license for loading and unloading activities in relation to dangerous goods on railway transport by Federal State Unitary Enterprise "Alexandrov Research Institute of Technology Sosnovy Bor, Leningrad Region" (Rus.).

Environmental Impact Assessment (EIA) materials on the commissioning as well as decommissioning of ARIT nuclear power facilities are reviewed by specially created commissions of the national nuclear safety regulator (Rostechnadzor), and, according to Russian law, should not be discussed with the public. At the same time, according to the Radium Institute,[22] ARIT is one of the main polluters of ^{3}H and radioactive elements - corrosion products ^{60}Co, ^{54}Mn, and ^{137}Cs to the Gulf of Finland.

There have been at least five accidents and incidents during the operation of ARIT's nuclear facilities[23]. One of the most serious accidents occurred on April 25, 1972. The core of the VAU-6c nuclear power plant burned out (80% of fuel assemblies were destroyed)[24]. The reactor lid had lost its tightness. *"The accident was caused by factors that could not have been taken into account in the design of the plant,"* was the conclusion of the special commission that investigated the accident.

Thus, the experts confirmed the possibility of unpredictable operation of the nuclear power reactor and the impossibility to guarantee its safety.

Another serious accident at another ARIT facility occurred in 1979. As a result of a thermal explosion of an element of the reactor's emergency cooling system (a water tank), the building was destroyed. Two people died.

Ecomet-S

In 1995, the Government of the Russian Federation adopted a National Program[25] to process approximately 600,000 tons of medium- and low-level radioactive metallic waste accumulated in Russia. A private company, Ecomet-S, was appointed lead contractor for this program. Only one of the 20 plants planned in Russia was built, and it was at the Leningrad Nuclear Power Plant. It was put into operation unlawfully in 2002, without public hearings and state environmental impact assessment.

By 2020, tens of thousands of tons of radioactive waste containing ^{54}Mn, ^{60}Co, ^{65}Zn, ^{106}Ru, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{90}Sr had been processed at Ecomet-S. Radioactive waste was supplied for reprocessing by enterprises of Rosatom and the Russian oil and gas complex.

Ecomet-S plans to process about 3,000 tons of metallic RW when LNPP is decommissioned.

Ecomet-S and LNPP[26] are the main facilities of the nuclear cluster for contamination of ^{137}Cs and ^{60}Co, but Ecomet-S is ranked first among all enterprises for environmental pollution ^{226}Ra, $^{235+}$ ^{238}U.

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[22] The report on the work "Comprehensive environmental expert assessment of the technogenic impact on the population and the environment of nuclear power facilities located in the territory of the Sosnovy Bor's urban district", (Rus.), approved by V.P. Tishkov, Acting Director General of Federal State Unitary Enterprise "Radium Institute named after V.G. Khlopin", 14.11.2011, SPb., 223 pages.

[23] Aleksandrov Research Institute of Technology 40 years. – SPb., LLC Research Center "Morintech", Rus. 2002 – 360c.

[24] E.V. Akkuratov et al., City of Sosnovy Bor, Faces of Russia, (Rus.), 1998, p. 118.

[25] Order of the Government of the Russian Federation No. 1197-r of September 1, 1995 on the approval of the Target Program "Processing and disposal of metal radioactive waste" and entrusting Ecomet-S with the function of the main executor of the Program (Rus.), http://docs.cntd.ru/document/9013443

[26] The report on the work "Comprehensive environmental expert assessment of the technogenic impact on the population and the environment of nuclear power facilities located in the territory of the Sosnovy Bor's urban

There have been several explosions in electric melting furnaces at the plant, resulting in the deaths of three workers (2005) and disabilities (2011).

Federal Environmental Operator (FEO), Leningrad Branch of the Northwestern Territorial District

The company is the legal successor of the Leningrad specialized plant "Radon", which has been operating since 1962. This was the first radiation-hazardous enterprise on the territory of the current nuclear cluster. It temporarily stores solid (more than 65,000 m^3) and liquid (1,200 m^3) RW of medium and low activity, as well as spent radioactive sources (medium-radioactive waste).

According to the available information, after extinguishing fires in 1976 and 1979 in the FEO, as well as a result of atmospheric leakage into these storage facilities, groundwater near the storage facilities is contaminated with ^{3}H, ^{137}Cs, ^{90}Sr, and ^{239}Pu.

The FEO is one of the main sources of ^{3}H discharges to the Gulf of Finland. The volume of discharges is $8 \div 20 \times 10^{7}$ Bq/year. It is comparable with ARIT discharge of these radionuclides to the Gulf of Finland.

Discharge of alpha-active (^{210}Po and ^{239}Pu) and beta-active (^{137}Cs, ^{90}Sr, ^{210}Pb) radionuclides into the Gulf of Finland is $2 \div 3 \times 10^{7}$ Bq/year.

Monitoring the impact of a nuclear cluster on the environment

Since the early 1970s, radiation and, later, comprehensive environmental monitoring has been carried out in the area of the nuclear cluster. Until the mid-1980s, the ARIT Regional Ecological Laboratory obtained results indicating serious negative ecological consequences for the aquatic ecosystems of the Koporskaya Bay of the Gulf of Finland.

This was a consequence of thermal pollution by the cooling systems of the Leningrad NPP against the background of the existing chemical and biogenic pollution of coastal waters. As a result, there was a multiply accelerated eutrophication of waters, year-round vegetation of plankton, as well as undermining the reproduction of fish due to death during the intake of water by cooling systems of power units, as well as deterioration of environmental conditions in the area of spawning grounds.

The regional environmental laboratory was funded by the nuclear industry and the results were not available to the general public.

district", (Rus.), approved by V.P. Tishkov, Acting Director General of Federal State Unitary Enterprise "Radium Institute named after V.G. Khlopin", 14.11.2011, SPb., 223 pages.

Evolution of the nuclear cluster after the Chernobyl disaster

After the Chernobyl disaster, in 1992, the administration of Sosnovy Bor commissioned a comprehensive analysis of the social and environmental situation in the city, an assessment of social and environmental risks, and recommendations for the development strategy of the city.

The work was carried out by the Russian Academy of Sciences[27].
The experts pointed out:

1. Lack of all-inclusive information in hands of the municipal authorities on the environmental state of the city due to the non-systematic nature of its collection by various departments.
2. Increased danger of the spread of pollution in case of accidents or leaks at nuclear-hazardous enterprises due to the peculiarities of the geo-environmental situation.
3. Decrease in the quality of coastal waters and their fishing and recreation potential because of changes in the species composition of phytoplankton in the Koporskaya Bay which occurred because of thermal, biogenic and chemical pollution.
4. The region's lead in cancer and pneumonia diseases, as well as the need to study congenital pathologies and cancer among children, taking into account the parents' place of work.

Scientists came to the conclusion that the ecological capacity in the area of the city and the nuclear cluster has been exhausted, and they recommended not to increase the city's population as well as the anthropogenic load on natural ecosystems.

It was also proposed to create a municipal center for environmental information activities and environmental monitoring so that the local authorities could conduct an effective social and environmental policy.

Most of these recommendations by experts of the Russian Academy of Sciences were not taken into account.

In the decade that has passed since this examination, the capacity of the temporary storage of spent nuclear fuel of the LNPP has been increased by 2 times, two new experimental nuclear facilities in ARIT have been put into operation, and the largest in Europe plant for the processing of the metallic radioactive waste of JSC Ecomet-S has been put into operation.

During the Unit 1 overhauls in the period from 1990 to 1998 at the LNPP, annual releases of long-lived nuclides ^{137}Cs, ^{134}Cs, and ^{60}Co increased by 100 - 300 times[28].

Therefore, it is no accident that in the late 1990s, geneticists of the Research Institute of Agricultural Radiology from Obninsk and specialists of the ARIT Regional Ecological Laboratory

[27] Report and conclusion of the expert commission on a comprehensive analysis of the situation in the area of Sosnovy Bor (according to the data provided by the customer), (Rus.), St. Petersburg Scientific Center "Association of Scientists of the Future of St. Petersburg" Russian Academy of Science, St. Petersburg, 1992, p. 83, approved. Corresponding Member Russian Academy of Science, deputy Chairman of the Presidium of the Russian Academy of Science Sergey. G. Inge-Vechtomov, inv. No. 018-ES.

[28] Comprehensive environmental expert assessment of the technogenic impact on the population and the environment of nuclear power facilities located on the territory of the Sosnovy Bor's urban district ", (Rus.), report on the work of the Federal State Unitary Enterprise (FSUE)" Scientific and Production Association "Radium Institute named after V.G. Khlopin ", Book 1, 143 pages, approved in December 2011 by Ph.D. V.P. Tishkov, Acting Director General of FSUE "Scientific and Production Association" Radium Institute named after V.G. Khlopin ".

(reassigned to the V. G. Khlopin Radium Institute) discovered cytogenetic damage to the seeds and needles of pine trees growing near the nuclear cluster and in the city of Sosnovy Bor[29].

The percentage of cytogenetic damage in the area of the nuclear cluster is 3 times higher and in Sosnovy Bor 2 times higher than in the control point, 30 km to the west of the nuclear cluster, near the village of Bolshaya Izhora, on the border with St. Petersburg.

Shortly after receiving these results, the Regional Ecological Laboratory of the Khlopin Radium Institute was closed. As a result, comprehensive environmental monitoring was discontinued, which makes it possible to assess not only the volume of releases and discharges of radioactive and chemical pollutants into the environment, but also the response of ecosystems to such anthropogenic impacts.

As a result, decision-makers on the development of the nuclear cluster have lost the opportunity to rely on the assessment of the state of natural ecosystems in their decisions. Their decisions were based on the criteria of economic benefit and political expediency.

This was followed by the abolition of post-Chernobyl standards that prohibited the construction of large nuclear power plants near megacities, as well as limiting the number of nuclear power plant satellite towns and their distancing from the plant.

This made it possible to build new power units of the Leningrad NPP with VVER-1200 reactors within the distance of 40 km from St. Petersburg, the previous limit was 100 km. After the abolition of the post-Chernobyl standard SNiP 2.01.51-90, paragraph 3.5, it became possible to increase the population of the city of Sosnovy Bor to more than 50 thousand people (68 thousand now) and develop the city closer than the previous 8 km to the nuclear cluster. The current limit is 3.5 km now.

Landmark events in 2020 for further development of the nuclear cluster

In 2020, a road map was adopted for the construction of LNPP Units 7 and 8 with VVER-1200 reactors. According to this document, public discussion of EIA materials and license justification materials for the construction of the units is scheduled for July 2021, and the state environmental impact assessment for November 2021. The construction permit is planned to be obtained in July 2022, and the reactors are to be physically commissioned in 2026 and 2028.

Thus, the planned commissioning of LNPP Units 7 and 8 with VVER-1200 reactors is 1-3 years behind the scheduled dates of the final shutdown of Units 3 and 4 with RBMK-1000 reactors. This may mean that for LNPP Units 3 and 4 the service life can be additionally extended beyond 45 years until Units 7 and 8 are commissioned.

In 2020, the first batch of secondary radioactive waste generated after radioactive metal processing at Ecomet-S was sent to a national Radioactive Waste Disposal Facility (RWDF) in Novouralsk, a closed administrative and territorial entity (CATE, Russian abbreviation is ZATO) in

[29] Comprehensive environmental expert assessment of the technogenic impact on the population and the environment of nuclear power facilities located on the territory of the Sosnovoborsk urban district", (Rus.), report on the work of the FSUE "Scientific and Production Association "Radium Institute named after V.G. Khlopin"", Book 1, 143 pages, approved in December 2011 by Ph.D. V.P. Tishkov, acting Director General of FSUE "NPO" Radium Institute named after V.G. Khlopin ".

the Sverdlovsk Region. Ecomet-S reportedly intends to move radioactive waste to the Urals until 2023[30].

Thus, Ecomet-S on the Baltic coast and the RWDF in Novouralsk have become part of a business project for reprocessing and disposal of radioactive waste. At the same time, neither the public nor the regional authorities of the Leningrad and Sverdlovsk Regions have adequate information about the long-term consequences for regional ecosystems of this business on radioactive waste.

In 2020, Vladimir Grachev, advisor to the head of Rosatom and organizer of the public environmental review of EIA materials in Sosnovy Bor in 2007, was arrested while accepting a bribe for lobbying business interests[31,32,33]. This event calls into question the results of the public examination that the VVER-1200 power unit has "no slightest impact"[34] on natural complexes.

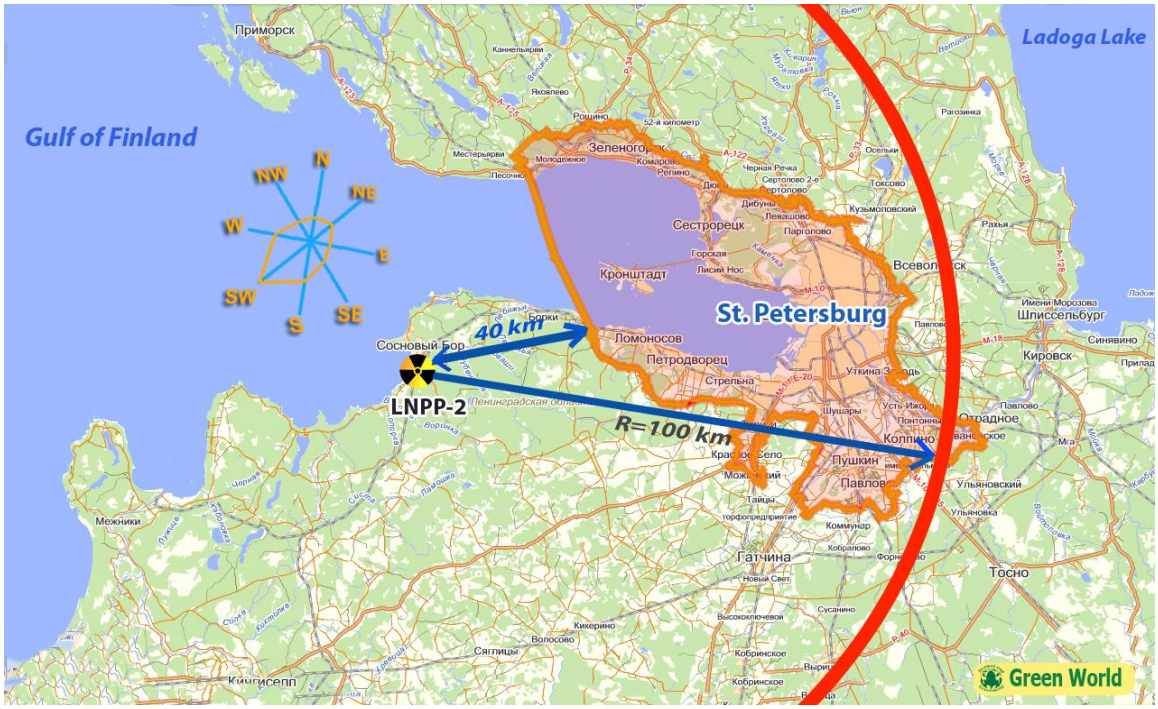

Figure 3. The post-Chernobyl standard (SNiP 2.01.51-90 3.5) was abolished so that it became possible to build LNPP power units closer than 100 km from the border of St. Petersburg.

[30] Viktor Kazakov, Novouralsk Radioactive Waste landfill. Opening of the winter season. (Rus.), https://novikvsluh.blogspot.com/2020/10/blog-post.html?fbclid=IwAR0OBUwqOsCtL05-JtsFj92h4IC1Yy3dx1VMNgqMAWongFGj0QqQ6E3Lkq0&m=1

[31] In Moscow, the court sent the adviser to the head of Rosatom under house arrest, (Rus.), RBC,17.09.2020 https://www.rbc.ru/rbcfreenews/5f62d5699a7947be2d676626

[32] The ecologist handed over the watch to the investigation. Former head of the State Duma environmental committee placed under house arrest, (Rus.), newspaper Kommersant 16.09.2020, https://www.kommersant.ru/doc/4493672

[33] Former head of the State Duma environmental committee placed under house arrest, (Rus.), Radio Liberty 17.09.2020. https://www.svoboda.org/a/30843336.html

[34] V. Grachev, "Not the slightest impact", (Rus.), newspaper Mayak of the municipality of Sosnovy Bor, 11 July 2007 https://mayaksbor.ru/news/atomgrad/ni_maleyshego_vozdeystviya/

Findings and conclusions

In the next 10 years, the nuclear cluster in Sosnovy Bor is expected to view the simultaneous operation of new and old LNPP power units. It is also planned to commission a nuclear power unit with a liquid metal coolant that is currently under construction at ARIT.

It is well known that such systems have a higher probability of accidents in the initial period of operation, as well as when they approach the design limit. In the first case, this is due to possible mistakes of designers, builders, and insufficiently experienced personnel. In the second case, the probability of accidents increases due to the "fatigue" of structural materials.

This means that Sosnovy Bor's nuclear cluster is entering a dangerous stage in its life. The political decisions to further increase the number of nuclear-hazardous facilities near the Gulf of Finland and to decommission them are not based on comprehensive safety analysis of the nuclear cluster and an assessment of the ability of ecosystems to absorb additional loading without destroying the reproduction mechanisms of a healthy habitat.

The history of the nuclear cluster development on the southern shore of the Gulf of Finland has demonstrated the need to include environmental and social criteria to assess the safety of nuclear cluster facilities. Additional tools are also needed to ensure the nuclear, environmental, and social safety of the nuclear complex. In particular, this includes:

1. Establishment of an inter-regional environmental laboratory (institute) under the auspices of the governments of Leningrad Oblast and St. Petersburg and the control of the Board of Trustees with the participation of all stakeholders. This will ensure comprehensive environmental and radio-environmental monitoring of natural ecosystems in the nuclear cluster area and provide recommendations to decision-makers on possible options for nuclear cluster development.
2. The Government of the Leningrad Region to initiate a strategic environmental assessment, the implementation of marine spatial planning procedures to ensure sustainable development of the southern coast of the Gulf of Finland, taking into account the decommissioning of the Leningrad NPP power units and plans for further industrialization of this region.
3. In order to take into account the interests of regional communities, social and environmental safety criteria, it is necessary to develop laws of the Leningrad Region and St. Petersburg on the powers of regional, municipal authorities, and the interested public when making decisions on nuclear projects on the shores of the Gulf of Finland.

3. Lake Imandra as a cooler for old Kola NPP reactors

Yuri Ivanov, Public Eco-Social Movement "Kola Ecocenter"

Summary

Kola Nuclear Power Plant is located in Poljarnye Zory by lake Imandra, and its four reactors are cooled by water from the lake. In 2020, EPS raised the topic of a lake Imandra as the single source of drinking water for residents in Apatity and Poljarnye Zori, with a total of 73 000 residents totally dependent on the purity of this water. Several consultations and round tables with authorities and the nuclear sector were held, that established a common understanding that a reserve drinking source needs to be established. During these it was clarified that also the city Kandalaksha, with a population of 31 000, has its single drinking water source connected to lake Imandra.

Introduction

In Russia, as well as in other countries, a direct flow system is used to cool nuclear reactors. This means that water for cooling nuclear power units is taken from natural water bodies - rivers, lakes, seas. Moreover, very often these water bodies are sources of drinking water for residents of settlements located near NPPs. In case of emergency discharges of the nuclear power plant there is a probability that liquid radioactive waste will be released into the natural cooling pond. This is a threat to the health of the inhabitants of the settlements who use this water for household needs. In view of this, in 2006 article 34 was added to the Water Code of the Russian Federation, which obliges regional and municipal authorities to provide reserve underground water sources. In this context, EPS investigated the situation in the city of Apatity in Murmansk Oblast in 2020, and also for Poljarnye Zory. Apatity is located by lake Imandra and has 55 000 residents for whom the single source of water supply is the lake which is also the coolant for four reactors of the Kola NPP. Poljarnye Zori with its 18 000 residents hosts the nuclear power plant, and like Apatity the city uses Imandra as drinking water supply. It has also been discovered later that the situation is the same in Kandalaksha, where residents have Niva River, which connects Imandra Lake with the White Sea, as a single drinking water supply. In 2019, about 31,000 people lived in the city of Kandalaksha, which makes a total of 104 000 residents depending on clean water from Imandra.

Background

Lake Imandra is one of the largest lakes of the Kola Peninsula, and it is actively used not only by the local population, but also by industry. Since 1973, the lake has been used by the Kola NPP for direct cooling for its power units.

Lake Imandra is a unique natural body of water on the Kola Peninsula. The length of the lake is 109 km, the average width is about 3.19 km, and the area with the islands is 880.4 km2. The catchment area of Imandra is 12,3 km2. The lake includes three water bodies (stretches):

Bolshaya Imandra, Yokostrov Imandra, and Babinskaya Imandra. They are connected by narrow straits (salmas).

The Bolshaya Imandra is the deepest part of the lake, while Yokostrov Imandra has the largest area. There are two large islands in Babina Imandra: Erm and Rovat. At the moment, Rovat Island is a peninsula because of the artificial dam in the area of Narrow Salma. The hydrographic network of the lake consists of 1379 watercourses and 2495 lakes. Watercourses are mainly small streams. All rivers and streams that flow into Lake Imandra are of the mountain and lake-marsh types. Only the Niva River, which flows into the Kandalaksha Bay of the White Sea, flows out of the lake[35].

Imandra lake and nearby cities. Source: Google maps

2020: General outline

Recently, emergencies affecting different water bodies have become more and more frequent. Both nature and inhabitants of polluted water bodies, as well as inhabitants who live on their shores, suffer.

[35] Moiseenko T.I., Lukin A.A., Kudryavtseva L.P. et al. Anthropogenic modifications of the Imandra Lake ecosystem. Moscow: Nauka, 2002.

In 2020, there were quite a few accidents at water facilities in Russia. On May 29th, one of the major environmental disasters of federal scale occurred because of the depressurization of a diesel fuel tank at CHPP-3 in Kayerkan (Norilsk district)[36]. Oil products leaked into the environment. A leak of over 21,000 tons of diesel fuel spilled far beyond the industrial zone. According to preliminary estimates, 6,000 tons of it found its way into the ground, and 15,000 tons into the Daldykan River, the right tributary of the Ambarnaya River flowing into large Lake Pyasino (the third largest in Krasnoyarsk Territory and the 16th largest in Russia), from which flows the Pyasina River engulfing into the Kara Sea.

Since June 10th, a strange spot on the Umbozor (Murmansk region) began to be recorded with the help of images from space[37]. According to many factors it was possible to understand that this phenomenon was most likely of technogenic character. On June 11, this process started to spread further. On June 15, EMERCOM of Russia in Murmansk Region and the Ministry of Natural Resources identified the causes of the phenomenon. An operative group of EMERCOM of Russia for Murmansk region was sent to the area to clarify the situation. In September, the guilty parties of the spill became known. According to the Rosprirodnadzor's response, the culprits of the incident were AO Apatite and AO Northwest Phosphorous Company[38].

In late September, the first reports came in that many dead marine animals had been found on Khalaktyrsky Beach on the east coast of Kamchatka[39]. Local surfers noticed that the color of the water had changed, and they themselves got swollen eyes and skin irritation. During the first stage, all possible variants of technogenic contamination were checked: dumping of toxic chemicals from Kozelsk test site into the ocean, leakage of rocket fuel from the military testing ground Radygino, but nothing was found. The preliminary cause of mass death of marine animals was oxygen starvation due to so-called red tide, i.e., rapid development of microalgae producing toxins. However, not all experts and scientists agree with such conclusions.

All of these incidents and accidents show how vulnerable aquatic ecosystems are, as well as the inability to predict the occurrence of such sudden accidents at industrial and energy facilities.

Industry and energy

In the middle of the last century, active mining began on the Kola Peninsula. This led to the issue of supplying these enterprises with electricity. To solve this problem, it was decided to build the Kola NPP. In 1973, the first power unit of the plant was commissioned, and in subsequent years, the remaining three power units were put in service. At present, all four reactors are in operation. In addition to the Kola nuclear power plant, there are also mining and processing facilities for apatite deposits and copper-nickel smelting, as well as iron ore production near the lake.

From its start with the first reactor commissioned in 1973, the Kola NPP has used water from Lake Imandra to cool its reactors. This cooling system is called direct-flow cooling. Water is taken from the Yokostrov Imandra and is after use discharged into the Babinsk Imandra, heated

[36] https://ru.wikipedia.org/wiki/Утечка_дизельного_топлива_в_Норильске
(Diesel fuel leakage in Norilsk)
[37] https://kec.org.ru/umbozero-izmenilo-cvet/
[38] https://www.tv21.ru/news/2020/08/26/nazvany-vinovniki-zagryazneniya-umbozera-v-murmanskoy-oblasti
[39] https://ria.ru/20201021/kamchatka-1580674426.html

by 10-20°C. Due to the strong currents that exist in the big lake, during the operation of the plant for almost 50 years, the water has undergone quite a few intake-to-discharge processing cycles[40].

Water Code

According to Article 51 of the Water Code of the Russian Federation, new production facilities with a direct-flow cooling system are prohibited for construction and operation. Article 34 of the same document states that if this method is operated at old plants, underground backup water sources are mandatory for settlements that use water for drinking and domestic needs. All this indicates that such a system is hazardous and obsolete for use in industry. The straight-line system is expedient due to its cheapness, unlike, for example, the use of "wet" or "dry" cooling towers.

Official requests on backup water sources

This situation raises the question of the reserve underground sources of water supply of the city, mandatory under Article 34. The same article states that the responsibility for the reserve sources lies with the regional authorities. In order to get an answer to this question, EPS made inquiries to the government of Murmansk Oblast, the Main Department of EMERCOM of Russia in Murmansk Oblast, the administration of Apatity and the water resources department of the Dvinsko-Pechorsky BWMB in Murmansk Oblast.

These official requests were also forwarded to the Committee for Public Safety of Murmansk Oblast, the Ministry of Natural Resources and Environment of Murmansk Oblast, Rospotrebnadzor, and the company which provides water directly to residents of Apatity, i.e., Apatityvodokanal.

Adequate answers came from the Ministry of Natural Resources and Environment of the Murmansk region. Officials from the ministry said that the city of Apatity has an underground water body with explored reserves of groundwater, which is protected from pollution and contamination. However, there were no references to where these underground water reserves are located, and whether there is an infrastructure which allows to quickly switch to these water sources in case of an accident.

Representatives of AO Apatityvodokanal, the organization responsible for water supply in Apatity, answered that they had no information about the availability of reserve underground water sources that could be used in an emergency or extraordinary situation.

Conclusion

As a result, the situation is as follows: 104 000 residents in Apatity, Poljarnye Zory and Kandalaksha will have their drinking water affected in case of emergency, in addition to population in many smaller settlements along the lake and the river Neva. The regional authorities have information about potential underground backup sources, while the service, which directly supplies the city with water, does not, nor even has it the infrastructure that would allow it to promptly switch the city's water supply to a backup.

[40] https://kec.org.ru/ozero-imandra/

This problem must be solved now, before any emergency occurs, and EPS will continue to pursue a fast solution. It should be noted that such a reactor cooling system is in use not only at the Kola NPP but also at other Russian nuclear power plants. This means that such a safety threat as loss of drinking water concerns not only the residents of the city of Apatity but also those residents of other regions who likewise use water from a natural source that is used to cool the reactors of other NPPs. The situation is complicated and requires a constructive solution pursuant to Russian law.

During a round table with several stakeholders is was also disclosed that there were no clear answers regarding the drinking water sources for the cities Monchegorsk and Olenogorsk, whether they are linked to the water bodies of lake Imandra and thereby can be affected by potential discharges of polluted water. We continue to pursue this question.

4. Uranium hexafluoride -waste or valuable raw material?

Andrey Talevlin (Russian Social-Ecological Union/ Friends of the Earth Russia and Movement "For Nature", Chelyabinsk)

Summary

The article deals with the problem of handling depleted uranium hexafluoride, as well as the issues of handling radioactive waste generated after its processing recycling. Environmental safety parameters around the uranium enrichment facilities in Germany (Gronau) and Russia (Novouralsk) are analyzed. A comparative analysis of the legal side of the issue and the practice of implementing contractual relations for the processing recycling of depleted uranium hexafluoride is given.

Introduction

Based on the international report of the nuclear Association, the world's nuclear energy production in 2019 increased as compared to 2018 and is now just below the record level of 2006.

During the same period, the number of active reactors decreased from 449 to 442. The total power generation capacity increased from 392 to 397 GW, mainly due to the increase in the capacity of existing reactors[41]. Moreover, in the countries of Eastern Europe, there was no increase in capacity. The nuclear fuel market has remained at the same level and according to the same report of independent experts[42], there will be no increase in the demand for nuclear power units in the near future. In general, the state of the nuclear industry continues to stagnate after the accident at the Fukushima nuclear power plant in 2011.The amount of radioactive waste (hereinafter referred to as RW) is constantly increasing, because, firstly, there are no reliable ways to dispose of RW in the world, and secondly, the process of decommissioning shutdown reactors has begun. In the meantime, the most common method of "disposal" is the storage of raw materials, and therefore their accumulation.

Recently, there has been a discussion in the literature and social networks about whether depleted uranium hexafluoride (hereinafter referred to as UF6) is radioactive waste. Let us recall that the UF6 is a by-product of the enrichment of natural uranium.

Background information

In most countries, UF6 de facto is considered to be radioactive waste, since the further use of this material in these countries is not provided for. However, de jure UF6 is not considered to be radioactive waste yet. For example, Germany has decided to shut down its nuclear power plants, considering them dangerous and ruinous for present and future generations. Now

[41] WNISR 2020. World nuclear industry status report. The Independent Assessment of Nuclear Developments in the World https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2020-HTML.html
[42] WNISR 2020. World nuclear industry status report. The Independent Assessment of Nuclear Developments in the World https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2020-HTML.html

Germany is faced with the task of getting rid not only of RW, but also of all "by-products" of nuclear materials and radioactive substances. Not only Germany, but also France, Belgium and other countries are interested in reducing the cost of recycling UF6. Therefore, they try not to accumulate UF6 there. We have compared two reports on the environmental safety of an enterprise in Gronau (Germany, Urenco)[43] and Novouralsk (Russia, Rosatom)[44]. According to the reports, there are no large volumes of UF6 accumulation in Gronau, although the company is still operating at the present time. And in the future, Gronau does not plan to use these "valuable raw materials", as Russian authorities call it. Table 1 shows some characteristics of enterprises related to energy consumption and consumption of natural resources.

Table 1

№	**Parameters and characteristics**	**Germany, Urenco**	**Russia, Rosatom**
1	Total area of the production site (ha).	76,2	164,5
2	Total electricity consumption in 2018 GWh	116	1012,3
3	Total consumption in 2018 (m3)	7841	3 000 000
4	Water disposal	After treatment, the discharge is to the public sewer	6 200 000

At present, Rosatom proposes to solve the European problem of the UF6 by "re-enriching" it with subsequent abandonment (about 90%) of RAO in Russia. With the help of the legislative and executive branches of the Russian government, back in 2001, Article 50 of the Law "On Environmental Protection" was amended to remove the ban on the import of spent nuclear fuel and other nuclear materials and (or) radioactive substances to Russia. After that, other regulations were changed, which kindly opened the country's gates for the import of radioactive materials from foreign countries, including UF6.

In fairness, it should be noted that despite the ban in the legislation on import into the RSFSR (and further to Russia) UF6 since 1991, in fact, such practice was carried out earlier.

Transportation of UF6 to Russia has been carried out since the days of cooperation of the Ministry of Medium Engineering during the USSR. So, in 1984, the French ship "Mont-Louis", carrying UF6 for the Soviet Union, collided with a car ferry and sank a few kilometers off the coast of Belgium[45]. The special operation to remove the containers with UF6 lasted almost two months. Thanks to the media (mostly foreign), information about transactions in relation to the UF6 became available. It turned out that back in 1973, a contract or contracts for uranium

[43] Umwelterklärung, Zweite Aktualisierung Urananreicherungsanlage Gronau, 2019б (German) https://urenco.com/cdn/uploads/supporting-files/UD-2019-August-19.pdf?fbclid=IwAR2r3PcxBJRhGOxp8eNfg8iYr1jQn0GcOUcrcMMmzhXkjsa6LwX6qwYXAYs

[44] Report on environmental safety of JSC "Ural Electrochemical Plant", 2019 (Rus.) http://www.ueip.ru/ekologicheskaya-politika/Documents/Отчет%20по%20экологической%20безопасности%20АО%20УЭХК%20за%202019%20год.pdf

[45] Bernard Augustin, Mont Louis Ship Accident and Nuclear Safety https://www.iaea.org/sites/default/files/27104592832_ru.pdf

enrichment were signed between the USSR and France. Judging by the above-mentioned sources, the USSR received UF6 from France, Germany and Belgium.

In 1996, information about a contract between Minatom and the international company Urenco became known. In 2009 there was a break in UF6 import to our country, and in 2019 imports resumed, despite many years of protests from the public that wishes to preserve the territory of their country suitable for future generations to live in.

As mentioned, Rosatom imports UF6 under the guise of a "valuable energy resource", although it returns only 10% (by volume). This means that from the imported material, Rosatom returns 10% of the enriched material to the export countries. 90% of the volume remains in Russia. From the point of view of RW management, the processing of UF6 is akin to the processing of SNF. The scheme is almost not different, and under the guise of valuable raw materials, SNF is exported for recycling to Russia. The RW from such recycling remains in the Chelyabinsk region, and the same fate awaits the Krasnoyarsk Territory in the future, as a repository for nuclear radioactive waste there is in process. Although the danger from the transportation of SNF is much higher, because it contains highly active radioactive substances and nuclear materials.

The danger of UF6 is primarily chemical; it is an active substance that reacts with water, including atmospheric moisture. When interacting with water, hydrofluoric acid and a compound of fluorine and uranium are formed, which is extremely dangerous for human health and the environment. Thus, the environmental safety of the UF6 depends primarily on the condition of the packaging container and the storage of the containers in the future.

Russia has accumulated its own RW with activity approaching 7 billion Ku, which is equivalent to 140 emissions from the Chernobyl accident. UF6 in Russia has already accumulated 1,200,000 tons. What part of this volume is from the Western European UF6 is left to guess. Based on the imported amount of UF6, Rosatom will need at least 100 years to recycle it. This fact proves that foreign UF6 is imported into Russia for the purpose of storage, which is ambiguous from the point of view of domestic legislation, since the import of RW for this purpose is prohibited. Additional Rosatom deals on the import of UF6 to Russia will only worsen the environmental safety of the future generations of Russians.

Development of the situation in 2020

As was already noted, the import of UF6 in 2019 was resumed, in 2020 the import began through the seaport of Ust-Luga (Leningrad Region). It is known from open sources that at least four deliveries of 600 tons were made in 2020. Apparently, such a volume is provided for by the safety standards for the ship "Michael Dudin" which is used to import UF6 from Germany.

From the license for the transportation of radioactive substances and nuclear materials, which became available thanks to German public figures, it follows that it is possible to carry out 20 transportations until 2023. It follows from the license that transportation can be carried out both from the Gronau plant and from the French enrichment plant in Pierrelat[46].

[46] Urenco Umwelterklärung. August 2019. In German. https://ecdru.files.wordpress.com/2020/06/dutchlicense.pdf

Many public associations of both Russia and European countries are against the veiled import of nuclear waste. Both in Russia and in Germany, there are protests. Representatives of public associations appealed to the presidents of Germany and Russia, as well as to the Director of the IAEA, with demands to stop the import of nuclear waste and not to move responsibility in the field of nuclear and radiation safety to other countries[47].

In addition, the Green Party of North Rhine Westphalia, October 27, 2020 proposed to the regional Parliament a resolution that prohibits the exports of wastes of uranium production from Germany. In particular, we are talking about the introduction of a ban on the export of uranium tails from the plant in Gronau, located on the territory of North Rhine-Westphalia. In addition, the Green Party lawmakers are proposing that the Federal Government introduces such a ban at the national level.

Left photo: ecodefense.ru

Right photo: greenpeace.ru

Conclusion

One of the possible ways out of this situation is to change the Russian legislation in order to make it mandatory to return all the waste generated from the processing (re-enrichment) of the DUHF to the importing country. In this case, nuclear technologies will really come to the fore, and not a veiled way of disposing of radioactive materials on foreign territory.

[47] Open message of Russian and German NGOs, supported by Russian deputies from nuclear regions http://rusecounion.ru/sites/default/files/inline/files/uf6-Putin-Merkel-letter.pdf?fbclid=IwAR0IhQ4_NDNe-eWk3uf6qDT6fhLzXM77fDfZzZwMueB_2d3aaqOmAALB2mo

5. Pressure on activists fighting against Rosatom's nuclear projects

Vitaly Servetnik (Russian Social-Ecological Union/ Friends of the Earth Russia)

Summary

The pressure on Rosatom's opponents has a long history. Many anti-nuclear organizations and activists have experienced pressure since the very beginning of their work. In 2012, a new wave of pressure on NGOs began, and the Ministry of Justice declared many anti-nuclear NGOs "foreign agents", including the *Ecodefense!, Green World* and the *Planet of Hope*, as well as organizations that are members of the RSEU: *For nature* and the *Kola Ecocenter*. Some of them were forced to close.

However, many groups and activists continued their work. The number of nuclear problems is not decreasing but growing, so new protest groups appear, which also meets pressure from the authorities. In this report, we will remind you of the history of persecution for anti-nuclear efforts and look at new cases.

In 2019, five criminal cases were filed against the director of the *Ecodefense!* Aleksandra Koroleva, which forced her to leave the country. Opponents of the import of German uranium waste (UF-6) into Russia were detained in Novouralsk and St. Petersburg. Activists who opposed uranium mining in the Kurgan region were facing threats, subjected to accusations by the Dalur Company, and criminal cases against them were filed. The activist Fyodor Maryasov in Krasnoyarsk, who opposed the construction of a repository for radioactive waste near the Yenisei River, was accused of incurring hatred towards the social group of "nuclear industry workers", and a criminal case on extremism was filed against him, and he received a warning about the inadmissibility of actions under the article on treason. A camp of activists opposing the construction of a road on the territory of a radioactive waste storage facility in Moscow was suppressed by the police, and the participants received numerous fines.

Introduction

The Soviet and Russian nuclear industry has a long and sad history. Chernobyl and Kyshtym are the most famous, but not the only problematic nuclear spots. Many problems left over from the times of the USSR have not yet been resolved.

Rosatom is a Russian state-owned corporation that builds and operates nuclear power plants in Russia and worldwide. The state-run nuclear industry in Russia has a long history of nuclear crises, including the Kyshtym disaster in 1957 and the Chernobyl

Since the 2000s, the less strict legislation on environmental protection and more strict on public participation, as well as the tightening of legislation against NGOs and civil society, have not helped to address these problems, but, on the contrary, opened the way for new problems to emerge. .

Since 2012, the enforcement of the Law on Foreign Agents has led to the liquidation of 22 out of 32 environmental NGOs declared foreign agents, of which at least 9 were engaged in anti-nuclear activism.

It is difficult to say with certainty which activists are subject to bigger pressure. For example, the number of detained and fined activists opposing landfills for household waste is many times higher. However, anti-nuclear activists are subject to more serious pressure: charges under articles of the Criminal Code, accusations of espionage, and, as a consequence, the need to leave their homeland and seek political asylum abroad.

Pressure on activists who oppose nuclear energy is a vivid example of the deadlock in relations between society and the state in the field of environmental problems. Lack of dialogue leads to this deadlock. All activists begin by trying to engage in dialogue with the authorities: filing appeals and complaints, participating in public hearings, but ignoring or neglecting their demands leads to the need to resort to protest actions.

Background

This chapter provides examples of pressure on NGOs and their activists who worked with nuclear issues in the 1990s and 2000s.

Green World was an organization working for nuclear safety on the Russian part of the south shore of the Gulf of Finland and St.Petersburg. Almost from the beginning of *Green World*'s activities in 1988, its activists experienced pressure from the authorities and the dirty nuclear business: there have been physical assaults to eliminate their work and lawsuits. Since 2013, pressure on *Green World* continued, and in 2015 the organization was recognized as a foreign agent and had to close down. *Green World* was replaced by the Public Council of the South Coast of the Gulf of Finland, and the activists continued their work in a new form but without deviating from their principles.

One of the first organizations that raised the problem of radiation pollution in the Ural region was the *Movement for Nuclear Safety*, formed in 1989.[48] In 2013, after unprecedented pressure and persecution, the organization's leader Natalia Mironova was forced to emigrate to the United States.

Since 2000, another non-governmental organization, *Planet of Hope*, has conducted thousands of consultations with affected citizens. Nadezhda Kutepova, a lawyer and head of the organization, won more than 70 cases in defense of Mayak's victims, including 2 cases in the European Court of Human Rights[49]. The state and Rosatom have reacted against the actions of Nadezhda Kutepova, persecuting both her and the *Planet of Hope*. The organization survived arbitrary inspections in 2004 and 2009, but was labeled a foreign agent in 2015 and closed in 2018.[50] After being accused of 'industrial espionage' and under the threat of criminal prosecution, Nadezhda was forced to flee the country with her children. She nevertheless continues her struggle to bring justice for the victims of *Mayak*.

Since 2002, the public foundation *For Nature* has been disputing nuclear activity in the region. In March 2015, *For Nature* was also listed as a Foreign Agent and fined.[51] In 2016, the court

[48] http://chel–portal.ru/enc/dvizhenie_za_yadernuyu_bezopasnost

[49] http://hudoc.echr.coe.int/eng?i=001-103084 (Eng.), http://hudoc.echr.coe.int/eng?i=001-158136 (Eng.)

[50] https://theins.ru/confession/81445

[51] https://www.rbc.ru/politics/18/03/2015/550812909a79475f79d367cc

closed down the organization.[52] In its place, a social movement of the same name was formed and continues to help the South Ural communities.[53]

The *Kola Environmental Center (KEC)* – listed as a foreign agent in 2017 – had to go through two trials and was fined 150,000 rubles.[54] The KEC was forced to close down as a legal entity in 2018 but continued its environmental work as a public movement.[55] Another organization in the region, the *Nature and Youth* decided to close down in order to avoid prosecution but continues its work as an unregistered movement .

The first environmental and anti-nuclear organization listed as a foreign agent in 2014 for the campaign against the construction of a nuclear power plant in the Kaliningrad region was the *Ecodefense!* Fines followed. In 2019, the pressure intensified: five criminal cases were opened against the head of the organization, Alexandra Koroleva,[56] after which she was forced to leave the country and received political asylum in Germany.[57]

Developments

This chapter provides examples of pressure on anti-nuclear activists in the past few years when the work of NGOs was already significantly restricted.

Importing German uranium waste

In the fall of 2019, environmentalists revealed that radioactive and toxic waste (uranium hexafluoride, UF6) was being imported to Russia from Germany through the port of Amsterdam. This is the waste from the uranium enrichment process which will be sent to the Urals or Siberia and stored in above-the-ground containers. Thus, under the auspices of a commercial transaction, the German uranium enrichment facility *Urenco* avoids nuclear waste problems, while Rosatom makes profits by taking the hazardous waste into Russia.

In response to this transaction, members of the *Russian Social Ecological Union* and *Ecodefense!* and *Greenpeace Russia* groups called on the Russian civil society to protest. More than 30 organizations and movements joined a common statement,[58] and various demonstrations have taken place in Russia, as well as in Germany and the Netherlands.[59] As a result of these protests, the issue of importing radioactive waste was taken up by the Legislative Assembly of St. Petersburg[60] , and the transportation of the waste was delayed for three months.

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[52] https://novayagazeta.ru/news/2016/12/13/127413–sud–v–chelyabinske–likvidiroval–priznannyy–inostrannyym–agentom–fond–za–prirodu

[53] https://za–prirodu.ru/page/ekspansija–nevezhestva

[54] https://profile.ru/society/ekolog–znachit–vrag–13271/

[55] https://kec.org.ru/organisation/histrory/

[56] https://foeasiapacific.org/2019/07/01/russia-must-stop-criminal-persecution-of-ecodefense-director-alexandra-korolyova-repeal-the-foreign-agent-law-and-promote-environmental-justice/ (Eng.)

[57] https://ecodefense.ru/2019/12/30/alexandra–koroleva–political–refuge/

[58] http://rusecounion.ru/ru/no–uf6

[59] http://activatica.org/blogs/view/id/8619/title/pochemu–nuzhno–ostanovit–uranovyy–poezd

[60] https://www.zaks.ru/new/archive/view/195957

However, in March 2020, when people in Russia were further restricted from protests during the Covid–19 virus quarantine, the import of radioactive waste was resumed through the port of the less populated town of Ust–Luga in the Leningrad Region. Additional organizations and residents of the Leningrad Region then decided to join the earlier anti-nuclear statement and protests.[61]

Following these protests, activists have faced harassment. Just like Sosnovy Bor, Novouralsk is a closed city in the Sverdlovsk Region dominated by the nuclear industry and it serves the destination point for the transported uranium hexafluoride. The city has rarely seen protests before. In response to a series of one-person protests, authorities have initiated legal cases against three pensioners at the beginning of December 2019.[62] Charges were later dismissed.

Another example is Rashid Alimov, an expert from *Greenpeace Russia*, who protested in the center of Saint Petersburg. Later the same day, two police officers together with six other ununiformed people detained Alimov right in front of his house. He then faced charges and a substantial fine.[63] Charges were later dropped.

Uranium mining protests in Kurgan

In the Kurgan Region, Rosatom's subsidiary company, Dalur, mines uranium and the local communities fear an environmental disaster. In the summer of 2019, a state environmental review revealed a discrepancy between Dalur's documentation and the requirements of Russian law, but the company nevertheless began developing the deposit in late 2019.[64]

The Dobrovolnoe uranium deposit is located in a floodplain of the Tobol River basin. This means that all water flowing into the river will pass through the aquifer, leaching radioactive and toxic compounds into the environment.[65]

Since 2017, Kurgan activists have been protesting against the development of the deposit. They have appealed to the authorities and then begun protesting. One of their videos, *Uranium is Death for Kurgan*, has already reached 50,000 views.[66] Several times, activists have tried to start a referendum and demand an independent environmental review, but so far, they have received only refusals from the local officials.

In February 2018, Natalia Shulyatieva, the spouse of activist Andrey Shulyatiev and mother of three children, died after she fell into a coma.[67] Activists believe this was in reaction to Dalur filing a lawsuit against her husband, accusing him of undermining the company's reputation. The lawsuit was withdrawn following Shulyatieva's death.[68]

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[61] http://rusecounion.ru/ru/decomatom_19320

[62] https://66.ru/news/society/226814/

[63] https://greenpeace.ru/blogs/2019/12/17/peterburg–ne–hochet–radioaktivnyh–podarkov/

[64] https://shtab.navalny.com/hq/kurgan/3687/

[65] https://novayagazeta.ru/articles/2019/11/08/82647–strana–uraniya

[66] https://youtu.be/irqY75jSnA8

[67] https://vk.com/wall–141292704_3351

[68] https://45.ru/text/gorod/53533571/

In March 2020, the Federal Security Service in the Kurgan Region initiated a criminal case against local eco-activist Lyubov Kudryashova accusing her of 'public justification of terrorism using the Internet'.[69] Activists attribute her persecution to her work at the *Public Monitoring Fund for the Environmental Condition and the Population Welfare* of which she was the leader back in 2017. The *Fund* has repeatedly published information on the possible environmental damage resulting from Dalur's mining activity.

Nuclear repository in Krasnoyarsk

In the city of Krasnoyarsk, Rosatom plans to build a national repository for high-level radioactive waste. A site has been selected on the banks of Siberia's largest river, the Yenisei, only 40 km from the city. Environmental activists consider this project, if implemented, to be a crime against future generations; it violates numerous Russian laws. Activists are also concerned that waste from Ukraine, Hungary, Bulgaria (and in the future from Belarus, Turkey, Bangladesh, and other countries) can be transported there as well.[70]

The community is understandably indignant, as no one wants to live in the world's nuclear dump. For more than 7 years, since 2013, the people of Krasnoyarsk have been protesting. To date, more than 148,000 people have signed the petition to the President of the Russian Federation protesting against the construction of this federal nuclear repository.[71]

Most of the nuclear power plants are located in the European part of Russia, but the waste is going to be sent for 'the rest of its lifetime' to Siberia. Local activists refer to this, with good reason, as the "nuclear colonization" of Siberia by Rosatom.[72]

In 2016, Fedor Maryasov, an independent journalist and leader of the protests, was accused of inciting hatred against nuclear industry workers as a social group. A criminal case was initiated under the article on extremism.[73] The basis for this accusation was 125 of his publications on social networks and the media publications on nuclear topics. The activist's apartment was searched, and his computer seized, along with a printed report on Rosatom's activities in the Krasnoyarsk Region.[74]

The Federal Security Service also issued an official warning for treason in the name of Maryasov. Only wide publicity in the media and the active support of human rights lawyers has thus far prevented further criminal prosecution of the activist.

[69] https://ovdinfo.org/express–news/2020/04/15/v–kurgane–fsb–vozbudilo–ugolovnoe–delo–protiv–ekoaktivistki
[70] http://babr24.com/kras/?IDE=198678
[71] http://www.change.org/mogilnik
[72] https://youtu.be/WTKfCnXt58Q?t=1729
[73] https://meduza.io/news/2016/08/25/krasnoyarskogo–aktivista–obvinili–v–razzhiganii–nenavisti–k–atomschikam
[74] http://greenworld.org.ru/sites/default/greenfiles/Mariasov_doklad_int.pdf

A road through a radioactive graveyard

Many hazardous radiation facilities across Russia are abandoned and require restoration. An example of this is the radioactive waste dump of the Moscow Polymetal Plant.[75] Since the beginning in the 1930s, the Moscow Polymetal Plant has processed monazite, containing thorium, uranium, and radium, and until 1972 the facility disposed of its tailings on the banks of the Moscow River. Eventually, the waste dump was abandoned and has since become a radioactive hillslope. Today, the headquarters of Fuel Company TVEL, a subsidiary of Rosatom are located on the place of the Moscow Polymetal Plant, while the company Radon, another subsidiary of Rosatom, excavates 10 - 15 cubic meters of waste from the hillslope annually. Given that there remain 15,000 cubic meters of waste, at this rate, it would take more than 1000 years to remove all of the buried waste.

At the public hearings in the spring of 2019, a city development plan indicated that a motorway bridge would pass close to the waste burial site. When asked what would happen to the radioactive waste, authorities replied that there was no radiation in the area.

Residents and activists of the region have conducted dozens of public environmental inspections of the radioactive hillslope. Among the residents and activists, they organized a civil control group called the 'Slope Defense' to monitor the hillslope. They have also installed signs to caution the public about radiation danger.[76] These actions have since attracted public attention.

Several roundtables were held to engage Moscow authorities in discussions, as well as within the State Duma[77] and in the Public Chamber of the Russian Federation[78], but official representatives have never come to these meetings. The authorities' response took place on the night of March 19, 2020: the lookout post for the 'Slope Defense' was demolished [79] and 63 community members were detained by the police.

Conclusion

In all the stories presented, we see that the methods and practices of the State Atomic Energy Corporation Rosatom lead to the creation of environmental problems, followed by conflicts with and, subsequently, pressure on anti-nuclear activists.

Critics of Rosatom are regularly subjected to pressure from the state, as a result of which environmental problems are silenced rather than addressed. Pressure on activists is a vivid example of a deadlock in relations between society and the state. Lack of dialogue leads to this deadlock.

The actions of the authorities and Rosatom pose a threat to the environment and future generations and must be stopped. The nuclear industry must be phased out, and this process

[75] http://rusecounion.ru/ru/horda_msk
[76] https://youtu.be/R9_9phYaWBE
[77] https://youtu.be/bMKfYD1SLdc
[78] https://youtu.be/l5K8agywCNw
[79] https://youtu.be/iXOyT0qPUi0

should take place under constant public control, in dialogue with local communities and environmental organizations.

Photo: Ticker zu Urantransporten
More details at http://rusecounion.ru/ru/20uf6

6. Decommissioning Russia's old nuclear power plant units: development 2015-2020

Kjersti Album (Naturvernforbundet/ Friends of the Earth Norway)

Summary

The share of Russian power reactors operating beyond their designed lifetime is still high, but the two oldest reactors at Leningrad nuclear power plant were finally stopped in 2018 and 2020 respectively. The total number of stopped nuclear power units is eight.

Decommissioning planning of Russia's closed power plant units has progressed during the last five years, but less than it should have. A general decommission plan for Russian reactors was made in 2017. In 2018, the "Concept for the decommissioning of power units of the Leningrad NPP with RBMK-1000 reactors" was clarified, and the "Program for the decommissioning of power unit No. 1 of the Leningrad NPP" was developed.

In 2020, an experimental and demonstration engineering center for the decommissioning of NPP units with channel-type reactors (ODIC RBMK) was created in Sosnovy Bor, in which it is planned to accumulate experience in decommissioning uranium-graphite reactors and its use during the decommissioning of Kurskaya, Smolensk, Bilibino and Beloyarsk NPP

For Kola nuclear power plant, there are no planning documents.

Decommission is a complex process that includes technical, environmental, economic, social and safety aspects. The above-mentioned planning documents only address the technical aspects. Both process and result could benefit from being more transparent and inclusive with a broader set of stakeholders involved.

Introduction

Russia's nuclear power reactors are aging. Approximately 63% of the operating nuclear reactors (24 of 38) passed their designed lifetime. In the last 5 years, 3 Russian nuclear reactors have been closed. More reactors will close in the nearest years.

Reactor units are closed at several nuclear power plants: Beloyarsk NPP, Novovoronezh NPP, Leningrad NPP, Bilibinskaya NPP. However, decommission processes have started only at Novovoronezh nuclear power plant and Leningrad nuclear power plant.

Decommission planning is essential for a good result, both environmentally, socially and economically. Lack of planning can also work as an obstacle of closure. There might be disagreement about the time of closure for nuclear reactors. But every reactor must close at some point, and proper planning cannot be overrated.

This article investigates Russia's decommission planning between 2015 and 2020 and sums up the main unsolved questions.

Background

Decommissioning of nuclear reactors is a complex process involving several aspects. The main aspects are briefly presented below.

The challenge of handling spent nuclear fuel (SNF) and radioactive waste

All over the world, the nuclear industry struggles to find acceptable solutions for the generated radioactive waste. The main problem is the time perspective. The waste must be kept away from people and nature for hundreds of thousands of years, varying between types of waste.

The lack of safe and secure solutions for the waste, hinders proper decommissioning. Moreover, it puts people and nature at risk from radioactive exposure. Often, sub-optimal solutions are chosen since proper solutions cannot be found.

Regarding the spent nuclear fuel, a small share of countries, including France and Russia, still clings to reprocessing and making new fuel, whereas most countries left this idea and will dispose of the spent fuel underground.

Technical challenges

The technical challenges will vary according to reactor type and contamination levels. Those that can learn from dismantling reactors of the same type, will get an easier job. As an example, the RBMK-1000 reactors at Leningrad nuclear power plant, might have something to learn from Ignalina nuclear power plant in Lithuania. Likewise, the decommission experiences of the VVER-reactors at Greifswald might be useful for decommissioning planning at Kola nuclear power plant.

Socio-economic challenges and mono-cities

Nuclear power plants and its suppliers are typically large workplaces. A reactor's closure can have a huge impact on the work market, both directly and indirectly. Jobs in the nuclear industry have generally been well paid.

In addition, the satellite towns of nuclear power plants often have little other business, and traditionally the nuclear industry has paid for recreation facilities and other benefits for the inhabitants.

Surely, inhabitants of the nuclear cities can be sceptical of decommissioning. However, lack of planning would make the situation even worse for the inhabitants. It is therefore important that inhabitants are included in the decommission planning process, and that their interests are taken into considerations.

Some places, the industry has hope and plans to build new blocks, as the new "solution". In Sosnovy Bor, the first new reactors of Leningrad nuclear power plant, are already built, and more are underway. However, this is not realistic in all places. For instance, we believe that the wishes of the industry to build new Kola nuclear power reactors, will not be reality. It is necessary to plan for diversification.

Knowledge and experience as arguments for immediate dismantling

A prompt dismantling allows for use of experienced personnel. Although dismantling a reactor demands other qualities and culture than operating one, the personnel of the reactor have useful knowledge of specific conditions and features.

A choice to delay dismantling, means losing site-specific experience of the personnel. On the other hand, lack of sufficient information can be an argument for delaying, while doing necessary research and planning. Some tasks will need to wait for radiation to decay.

Decommissioning planning and financing

As presented above, decommissioning covers several aspects. This raises both the need of proper planning, and also the need of involvement of all stakeholders.

Generally, the planning and preparations for decommissioning have not been satisfactory. Russian law demands a decommission concept must always be in place during the operation of the NPP unit and revised. A decommissioning program must be developed 5 years before the shutdown of the nuclear power plant unit.

Regarding the costs of decommissioning, the general rule is that it turns out to be more expensive than anticipated. Russia has a decommissioning fund. However, the fund was set up too late and too little money comes into the fund. Also budget money will be needed to pay for the decommissioning. This is not a specific Russian problem. In several other countries the collected funds are too small to pay for decommissioning and nuclear waste treatment.

Developments 2015-2020

This chapter covers the main developments of the five years 2015-2020. The developments are split in a general part, and in two sub-chapters to describe the plans and processes for Kola nuclear power plant and Leningrad nuclear power plant.

1. General planning for decommissioning in 2015-2020

Rosatom and Rostekhnadzor have developed official documents regarding the decommissioning of old nuclear reactors. These documents are at different levels:

Rosenergoatom's general decommission concept was published in 2017. This concept sets the frames for decommissioning of all Russian nuclear power-producing reactors, indicating the timing of the final shutdown of all nuclear power plants in Russia. This document outlines the goals and objectives of the process, the timing of the final shutdown of all power units of Russian NPPs. In addition, the conceptual requirements for preparation to the decommissioning of power units at all stages of the life cycle, including during the design of new power units, their operation, as well as after the final shutdown and decommissioning. The Rosenergoatom Concept provides possible ways of decommissioning, financing mechanisms for these works and training of personnel for decommissioning.

In 2020, an experimental and demonstration engineering center for the decommissioning of NPP units with channel-type reactors (ODIC RBMK) was created in Sosnovy Bor, in which it is planned to accumulate experience in decommissioning uranium-graphite reactors and its use during the decommissioning of Kurskaya, Smolensk, Bilibino and Beloyarsk NPP. ODIC is not a

structural subdivision of Leningrad nuclear power plant, it is an organization part of the Rosenergoatom Concern.

In addition, a concept specifically for Leningrad nuclear power plant has been made. The "Concept for decommissioning of power units of the Leningrad NPP with RBMK-1000" is covering all reactor blocks at the power plant. The concept says that Rosenergoatom plans to create a "Brownfield" on the site of all four Leningrad nuclear power units, by 2060.

In 2018, Rosenergoatom published decommissioning programs for the first and second reactor units at Leningrad NPP, in accordance with the concept[80]. These programs are more specific than the concept, for instance they include cost estimates. Eventually, decommission programs of other blocks at Leningrad nuclear power plant will be made, in accordance with the concept for Leningrad nuclear power plant, as well as the overall concept.

Still, detailed decommission plans for each reactor must be made, for each step of the dismantling process. The decommission plan for Leningrad nuclear power plant's first reactor is currently in the making.

Of relevant laws and regulations, the following should be mentioned:

On October 13, 2018, Presidential Decree No. 585 "On the Approval of the Fundamentals of State Policy in the Field of Nuclear and Radiation Safety of the Russian Federation for the Period until 2025 and the Future Prospect" was adopted. One of the goals of this decree is the development of the foreign economic activity of the Russian Federation in the field of nuclear energy use, including an increase in the volume of obligations to provide services to foreign countries in this area, including the reprocessing of spent nuclear fuel.

In connection with the adoption in July 2019 of the Federal Law "On Amendments to the Federal Law On Production and Consumption Wastes "and the Federal Law" On the State Atomic Energy Corporation "Rosatom", in addition to radioactive waste management, Rosatom has the authority to manage waste 1 and 2 hazard classes. In the near future, Rosatom is to create a unified state system for handling such waste. Thus, Rosatom today regulates the basic issues of handling both radioactive waste and hazardous industrial waste.

2.Kola nuclear power plant

The four VVER reactors at Kola nuclear power plant are planned to operate until 2033, 2034, 2036 and 2039 respectively. As far as we have been able to determine, no decommissioning planning has been made for Kola nuclear power plant, not even the lowest level of concepting.

All reactors will double their lifetime and run for 60 year each. Originally, they were designed for 30 years. Two of the reactors are first generation units, to are second generation units.

Unit number 2 received extension of its license on 20. December 2019, for another 15 years. Consequently, unit 2 will be in operation until 20. December 2034. The reactor was put into

[80] Information from the report *Decommissioning Russia's old nuclear power reactors. Status update on key processes 2019*, Chapter 3.Decommissioning of Leningrad nuclear power units: status of the process in 2019» by Oleg Bodrov. Available in English at naturvernforbundet.no/decommissioning-reports and in Russian at http://rusecounion.ru/ru/publication

operation in 1974, so the total operating time will be 60 years, the double of its designed lifetime.

In a letter in May 2019, quoted in our previous status report[81], acting director of Kola NPP, Mr. Marakulin reported that the decisions on continued operation
"were adopted and then executed as follows:
Unit No. 1 - the term of operation is extended by 15 years (until June 30, 2033);
Unit No. 2 - an investment project is currently being implemented on preparations for extending the service life to 60 years;
Unit No. 3 - the operation period is extended by 25 years (until April 4, 2036);
Unit No. 4 - the term of operation is extended by 25 years (until December 7, 2039)".

The acting director also informed that
"Planning for decommissioning of Kola NPP units is carried out at all stages of the life cycle by developing the concept of decommissioning of the NPP unit and its subsequent revision (clarification). 5 years before the end of the additional lifetime of each unit of the Kola NPP, an assessment (analysis) of its safety is carried out, based on which the operating organization (Rosenergoatom Concern JSC) decides on whether to continue its operation or to prepare for decommissioning. For the units of the Kola NPP, decisions on decommissioning were not taken."

The spent nuclear fuel from Kola nuclear power plant is being sent to the Mayak facility in Chelyabinsk for reprocessing.

Solid radioactive waste from Kola nuclear power plant is stored on site, only part of the solid radioactive waste is processed. To reduce the volume of this waste, a pressing method is used. The storage facilities use non-standard containers that are placed in temporary storage facilities of the station, as well as in production facilities. Metallic radioactive waste is transported to EcoMet-S in Sosnovy Bor, where it is melted and transported to Novo-Uralsk to the federal storage. This transportation is a simulation of a solution. The condition of this storage is secret, and we doubt that the standard is good enough.

Liquid radioactive waste is processed at evaporation facilities. Then these wastes are delivered to the liquid radioactive processing complex, where the waste passes the curing stage and converts into solid radioactive wastes and is being stored also at the station.

3.Leningrad nuclear power plant

The four RBMK-1000 reactors at Leningrad nuclear power plant will be decommissioned to a "brownfield" by 2060. Two of the reactors are closed, the last two will close in 2024 and 2025 respectively.

The first reactor at Leningrad nuclear power plant was stopped 21. December 2018, after operating 15 years longer than its designed lifetime of 30 years. The second reactor unit was stopped 10. November 2020.

[81] Information from the report *Decommissioning Russia's old nuclear power reactors. Status update on key processes 2019.* Chapter 2. Access to information, schedules and status of decommissioning conceptions and plans for NPP reactors, article by Vitaly Servetnik (Russian Social-Ecological Union / Friends of the Earth Russia). Available in English at naturvernforbundet.no/decommissioning-reports and in Russian at http://rusecounion.ru/ru/publication

Rosenergoatom has developed a "Concept for decommissioning of power units of the Leningrad NPP with RBMK-1000". Rosenergoatom plans to create a "Brownfield" on the site of all four Leningrad nuclear power units by 2060. A "Brownfield" end stage means that the site after decommissioning, can be used for industrial activities. This is an alternative to a "Greenfield", when the site after decommissioning returns to its natural state and can be used without restrictions. For example, to create a park, build a kindergarten, or in any other way.

Rosenergoatom has also developed decommissioning programs for the first and second reactor units, in accordance with the concept. Both programs were made in 2017 and put into effect on 1.March 2018[82].

As described in Oleg Bodrov's article "SOSnovy Bor and the nuclear cluster of the southern shore of the Gulf of Finland"[83], a decommissioning program for Power Unit 1 at Leningrad NPP has been developed and approved. After the final shutdown of the power unit and prior to the final removal of spent nuclear fuel from the reactor (up to 5 years), the annual cost of its operation without power generation will be more than 2.6 billion rubles, and the development of project documentation for the decommissioning is estimated at 800 million rubles. The expected cost of decommissioning of the first and second power units of LNPP, taking into account the costs of radioactive waste disposal, but without the costs of final isolation for spent nuclear fuel, will amount to 64 billion rubles.

The third and fourth power units are planned to be finally stopped in 2024 and 2025 respectively. They would have lasted 45 years, compared to their designed lifetime of 30 years. The closing plan follows the construction schedule of the new nuclear power units in Sosnovy Bor, at a nearby site.

More information on the handling of radioactive graphite in decommissioning of RBMK-type reactors, are available in the report "Radioactive graphite handling in decommissioning of RBMK-type reactors. Current challenges and possible solutions for radioactive graphite handling in decommissioning of RBMK-type reactors", by Oleg Bodrov, Vladimir Kuznetsov, Oleg Muratov and Andrey Talevlin[84].

By order of Rosenergoatom Concern JSC dated 29.November 2019 approved the "Roadmap for the establishment in Sosnovy Bor of an Experimental Demonstration Engineering Center (EDEC) for decommissioning of NPP units with channel-type reactor plants". This will provide an opportunity to accumulate experience that was first decommissioned from RBMK-1000 power units.

Some of the main challenges for decommissioning of Leningrad nuclear power reactors are

[82] Information from «3.Decommissioning of Leningrad nuclear power units: status of the process in 2019» by Oleg Bodrov, in the report Decommissioning Russia's old nuclear power reactors. Status update on key processes 2019, available in English at naturvernforbundet.no/decommissioning-reports and in Russian at http://rusecounion.ru/ru/publication

[83] Chapter 2 in this report, "SOSnovy Bor and the nuclear cluster of the southern shore of the Gulf of Finland" by Oleg Bodrov.

[84] Available in English at naturvernforbundet.no/decommissioning-reports and in Russian at http://rusecounion.ru/ru/publication

- The challenge of handling the radioactive graphite from the moderator. Currently the plan is to remove the graphite and place it in casks
- The challenge of spent nuclear fuel handling. Currently, spent nuclear fuel is transported to Zhelesnogorsk in Siberia, causing a social uprising in the local community. Also, experts worry about possible depressurization of fuel rods in Zheleznogorsk by the 2070s.
- The challenges of radioactive waste handling

The lack of social considerations, and a deficit of stakeholder involvement in the decommission planning, is evident. As an example, Rosatom and the Government of the Leningrad Region are not fulfilling their social obligations to put into operation a protected source of drinking water supply for 75,000 residents of Sosnovy Bor. A protected source of drinking water is a requirement of the Russian standards SNiP 2.01.51-90, as well as the Water Code of Art. 51 and 34.

Conclusion

Reactor units have been closed at several nuclear power plants: two at Beloyarsk NPP, 3 at Novovoronezh NPP, 2 at Leningrad NPP, and 1 at Bilibinskaya NPP. However, decommission processes have started only at Novovoronez nuclear power plant and Leningrad nuclear power plant.

Rosenergoatom and Rostekhnadzor have developed official documents regarding the decommissioning of old nuclear reactors. More detailed plans for decommissioning of Leningrad nuclear power plant's first reactors, are underway.

There are still unsolved questions. As all other countries in the world, Russia lacks long-term solutions for spent nuclear fuel and the radioactive waste. Transporting spent nuclear fuel away to more remote areas, is not a solution. At the RBMK reactors in Leningrad nuclear power plant, the graphite in the reactor core poses an additional challenge. Attempts have been made from civil society organisations, both local and Lithuanian, to discuss what to do with the radioactive graphite.

However, there is little public involvement in decommissioning processes. Transparency of information, and active involvement of different stakeholders, both local, regional and national, is vital for the result to be as good as possible. In addition to a better result, involvement from an early stage and throughout the whole process can lead to less conflict and less unnecessary delays.

References

Here you will find sources to the information in the article. These are also recommended as deeper reading. The references are sorted per chapter.
All reports can be found at http://naturvernforbundet.no/decommissioning-reports/ for English versions and at http://rusecounion.ru/ru/publication for Russian versions.

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