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Life Extension of Russian Nuclear Power Plants

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Executive summary

Russia is actively implementing a programme to extend the lifetime of nuclear power reactors beyond their engineered life span of 30 years. So far, the extension procedures have been implemented on the oldest reactors found in Russia: first generation VVERs and RBMKs, the Chernobyl-type reactors.

The lifetime extensions, especially on first generation reactors, do not guarantee safe operation because these reactors are of an inherently unsafe design, which cannot be improved through upgrades and modernisation. The economics of the lifetime extension are also questionable, and in most cases not feasible.

The extension is carried out in violation of Russian environmental legislation: none of the projects have undergone legally required state environmental assessments.

Conclusions

- Russia’s nuclear agency intends to increase the share of nuclear energy from the current 16 percent to 25 percent by the year 2030. The funding for these plans is still vague, however.

- To compensate for the lack of new capacity and to retain nuclear power as an important energy source, as well as maintain expertise in this field, Russia launched an extensive programme to prolong the lifetime of its older reactors. Not only does prolongation of the engineered live-spans of NPPs *not* reduce the list of hazardous factors involved, it actually increases them. This refers primarily to dangers as a result of NPP usage in everyday and emergency regimes. During lifetime extension, the reliability of systems and mechanisms cannot be guaranteed at the same level as new equipment. Moreover, older Russian reactors have inherent design failures, which are impossible to remove during life span extension work, as it would not be financially feasible.

- Proponents of lifetime extension say that it is economically feasible. Bellona believes that Rosatom simply has no funds to decommission the older NPPs, and thus finds questionable compromises with safety.

- The inherent problems of nuclear energy, such as the management of spent nuclear fuel, remain largely unresolved.

- Finally, there can be no doubt that NPP engineered lifetime extensions are taking place in breach of Russian legislation.

Introduction

The Russian Federal Nuclear Agency (Rosatom, formerly Minatom), has decided to extend the operation of nuclear power plants (NPPs) that have surpassed their projected-engineered life spans. Many scientists, experts and NGOs maintain that such practice by Rosatom is economically unjustifiable, environmentally dangerous – to say nothing of illegal. The Russian nuclear industry, however, argues that the lifetime extensions are justified because:

- The original estimate of a 30-year life span for current NPPs was conservative;
- Large-scale upgrades during the designed life spans have been carried out; and
- The financial costs of lifetime extension are significantly less than those of constructing new reactors.

The level of atmospheric pollution caused by NPP operation is incomparably lower than that of burning fossil fuels. However, for society, politicians, economists and other experts, there are other, much more pressing factors that effectively undermine all the supposed benefits of developing nuclear energy. These are: (1) the risk of proliferation of weapons-usable nuclear material; (2) severe hazards of potential accidents; and (3) the still unresolved issue of spent nuclear fuel (SNF) and highly radioactive waste (HRW) management.

In this position paper, Bellona examines the safety, economic and legal aspects of the lifetime extension practice at Russian NPPs and verifies the validity of Rosatom's pro-extension argumentation.

Nuclear energy in Russia

During the reform of Russia's nuclear energy sector in 2004, the Russian government created Rosenergoatom, the state monopoly operating nuclear power plants. Rosenergoatom data shows that 10 NPPs are currently active in Russia. They comprise 31 reactors with a total capacity of 22.2 gigawatts (GWt) and supply approximately 16 percent of the country's energy demand at a cost of approximately EUR 0.1 per kilowatt hour (about 13-15 percent lower than the average tariff for energy from thermal power stations in Russia).

Under the "optimal" variant laid out in the "Development Strategy for Russian Nuclear Energy in the First Half of the 21st Century," 39 nuclear reactors will be built by 2020, which – given that 12 reactors will have been taken out of service – will increase total generating capacity up to 52.6 GWt.[1]

Between 2000 and 2005, two reactors were brought online, in contrast to planned number of five. Construction of another reactor, at the Volgodonsk NPP, could be completed by 2010. Total generating power over the decade will grow by three, or, at best four GWt, instead of the planned 10.8 GWt. Thus, it is obvious that the development of nuclear energy in Russia is already far from following the "optimal" version as planned in the strategy.

In recent statements, however, Russian President Vladimir Putin reiterated that the goal for the nuclear share in the country's energy sector is still 25 percent by the year 2030. Sergey Kirienko, head of the Russian Nuclear Energy Agency, replied by laying-out a plan to start construction of two reactor units per year starting in 2007, and three to four reactor units per year staring in 2009-2010.

[1] "Development Strategy for Russian Nuclear Energy in the First Half of the 21st Century" was approved by the Russian government on May 25th 2000, protocol No. 17.

Extending the reactors' engineered life spans

Concurrent to finishing construction of new reactors, Russia is prolonging the service life of functional first-generation EGP-6, VVER-440 and RBMK-1000 type reactors by up to 15 years, and plans to move to a 15+30 (where 15 is the extended life span in years and 30 years is the engineered life span) scheme in the future. In particular:

- By the end of 2005, engineered life span extension work had been completed at seven first-generation NPP reactors;
- Between 2005 and 2008, Rosenergoatom plans to complete engineered life span extension work at four more NPP reactors whose projected service life runs out in 2006; and
- Between 2005 and 2008, Rosenergoatom plans to carry out engineered life span extension preparation work at another eight NPP reactors whose service life runs out after 2008 (up to 2013).

Detailed information on these reactors can be found in Annex 1.

Specificities of, and dangers associated with, the process of extending the engineered life spans of nuclear power plants

Based on definitions in legal documents, an NPP reactor unit is the part of a nuclear plant comprising the nuclear reactor itself, radiation sources, nuclear material and radioactive substance storage points, and waste storage. Therefore, extending the working life of NPP reactors also includes constructing or upgrading of the above-mentioned facilities. A decision on extending the engineered life span of a reactor, or on decommissioning it, <u>must be taken five years before</u> the end of the reactor's original projected-engineered life span.

Extending an NPP's lifetime beyond its engineered life span is inherently dangerous, in particular because certain parts are irreplaceable and because of the unresolved issues of spent nuclear fuel (SNF) and highly radioactive waste (HRW) management.

Indeed, during engineered life span extension projects, the components in need of replacement, and those that can serve further, if maintained regularly, are determined. Some parts of a reactor – including the reactor casing and its internal elements and constructions, the graphite stack (found in RBMK reactors), primary coolant circuits, primary coolant pumps and biological shield systems – are irreplaceable. The non-replaceable parts are crucial for the safe operation of a reactor, and of first generation reactors in particular.

In the case of the Kola NPP, for example, it would be necessary to replace the reactor casing in order to ensure safer operation. In addition, the proximity of the fuel assemblies to the steel walls in the VVER-440 reactor tank – such as those used at the two first units at Kola NPP – results in higher neutron irradiation than in other types of reactors, such that the walls of the VVER-440 become brittle at a higher pace than normal[2].

As can be seen from the legal requirements mentioned above, the life span extension procedure affects not just reactors and associated systems, but the whole system of handling SNF and nuclear waste at NPPs. Accounts published in the press and official documents on extending the engineered life spans of the Leningrad, Kola and other NPPs mainly deal with work carried out on reactors and associated systems. Bellona has information that shows that SNF storage facilities at all Russian NPPs operating RBMK-type reactors, and the Leningrad NPP in particular, are in critical

[2] Nikitin, A., et al. *The Arctic Nuclear Challenge*, Bellona report 3:2001.

condition[3]. At present, the Leningrad NPP does not meet one of the main requirements for a storage facility, namely that its construction should allow unloading of any pool at any moment to carry out emergency work.

Bellona data also show that SNF problems at the Bilibino NPP, operating EGP type reactors, are even more acute than at the Leningrad NPP. RBMK and EGP reactor type fuel cannot be reprocessed; it therefore remains in on-site storage facilities. Rosatom's decision to increase the capacity of on-site storage by doubling the number of fuel assemblies that storage brackets can hold is hazardous and does not resolve the issue of storing SNF for the time span by which the NPP's life is being extended.

The economics of nuclear power and lifetime extension

The cost of a new reactor at Finland's Olkiluoto NPP, to be built by Framatome, comes to EUR 3 billion. This is three-and-a-half to seven times higher than the investment in construction of a new thermal power plant with gas turbines, which, in addition, could be brought online three to four times more quickly than a nuclear plant.

In Russia the prices tags are also high. Spending on the completion of the fifth reactor at the Kursk NPP (EUR 560 million for 75 percent of construction) and the experience of the third reactor at the Kalinin NPP (EUR 825 million against estimates of EUR 225 million) are convincing evidence that capital investment will reach at least EUR 1.2 to EUR 1.3 billion per GWt in the Russian Federation.

But investors, including the state, would find that investing money in the development of nuclear energy is far from the best option for their capital, because of:

- The much slower turn-around of invested capital;
- High sensitivity to political risks; and
- The burden on the nuclear sector of deferred capital expenditure, decisions regarding the handling of SNF, radioactive waste and decommissioning of NPPs.

Recently, Rosatom has re-evaluated its strategy several times, and in the next 25 years intends to use Russian gas giant Gazprom's money to build up to 40 new reactors costing EUR 1.4 million each. But Rosatom's initiative to attract investment from Gazprom has been received by both Gazprom managers and experts without enthusiasm. For example, a number of Gazprom managers say that the construction of NPPs is currently ineffective because they are very expensive and inflexible to run, and create a permanent burden. Most likely, the question of investment in the nuclear sector will remain open for the time being, and will be resolved only when politicians move it from the field of economics to politics, which is quite likely.

To make the life span extension viable for RMBK reactors, it was calculated that the investments should not exceed a certain sum. However, Bellona's data show that this number has at least doubled during the lifetime extension projects, which makes the whole idea not only unsafe but also not viable economically.[4]

Western aid

Since the beginning of the 1990s, western governments have doled out billions of dollars on extensive programmes to upgrade the safety of Russian nuclear reactors so that they could operate safely until their operational life spans expired. In practice, this has unfortunately resulted in a

[3] See http://www.bellona.org/reports/Leningrad_NPP.
[4] The Leningrad Nuclear Power Plant, Bellona Working Paper, 2000. URL: http://www.bellona.org/reports/Leningrad_NPP

situation where most of the older first generation reactors were granted 15 additional years to operate.

Legal regulation of the engineered life span extension at NPPs

The legality of NPPs' engineered life span extensions has caused heated discussions both in civil society and among experts and has even been the subject of court cases. The important question raised during the heated debate is whether the state environmental expert assessments need to be carried out during the lifetime extension of NPPs.

Point 5.1.14 of general safety regulation (OPB-88/77) states that the organisation operating an NPP may raise the issue of extending an NPP reactor's engineered life span. In this case, a new license for the operation of an NPP reactor must be obtained from Gostekhnadzor, the federal nuclear oversight agency, under the established legal procedure. The procedure and conditions for licensing are set out in the Regulations on Licensing Activities in the Sphere of Nuclear Power Usage. Under Article 12 of these regulations, an NPP operating body must present the conclusions of a state environmental expert assessment, along with other documents. There is no other legal documentation requirements. There is therefore no question that a state environmental expert assessment should be carried out during the life span extension process. Under Article 19 of the federal law "On State Environmental Expert Assessments," citizens and civil society organisations have the right to information on the results of these assessments. In addition, the general public can organise social environmental expert assessments if information on the object of the assessment is not classified as a state, commercial, or other type of secret.

The accusations levelled against the nuclear industry regarding illegal NPP reactor engineering life span extensions are therefore fully justified. **<u>None of the reactors that received life span extension have undergone any environmental expert assessment</u>**.

ANNEX 1 – Overview of NPPs, their engineered life spans and lifetime extensions

Table 1. First generation NPP reactors whose engineered life span was completed by the end of 2005

NPP	Reactor unit	Type	Capacity (MWt)	Year launched	Projected end of service life (30 years)	Date of start of 15-year extension
Bilibino	1	EGP-6	12	1974	2004	Start 2004
	2	EGP-6	12	1974	2004	Start 2005
Kola	1	VVER-440	440	1973	2003	June 2003
	2	VVER-440	440	1974	2004	August 2004
Leningrad	1	RBMK-1000	1000	1973	2003	October 2004
Novovoronezh	3	VVER-440	440	1971	2001	December 2001
	4	VVER-440	440	1972	2002	December 2002

Table 2. Engineered life span extensions to be completed between 2005 and 2008

NPP	Reactor unit	Type	Capacity (MWt)	Generation	Year launched	Projected end of service life (30 years)	Projected extension (years)
Bilibino	3	EGP-6	12	I	1975	2005	15
	4	EGP-6	12	I	1976	2006	15
Kursk	1	RBMK-1000	1000	I	1976	2006	15
Leningrad	2	RBMK-1000	1000	I	1975	2005	15

Table 3. Engineered life span extension preparation work planned between 2005 and 2008 (for reactors whose service life runs out after 2008 and up to 2013)

NPP	Reactor unit	Type	Capacity (MWt)	Generation	Year launched	Projected end of service life	Projected extension (years)
Beloyarsk	3	BN-600	600	II	1980	2010	15
Kola	3	VVER-440	440	II	1981	2011	25-30
Kursk	2	RBMK-1000	1000	I	1979	2009	15
	3	RBMK-1000	1000	II	1983	2013	15-20
Leningrad	3	RBMK-1000	1000	II	1979	2009	15-20
	4	RBMK-1000	1000	II	1981	2011	15-20
Novovoronezh	5	VVER-1000	1000	II	1980	2010	25-30
Smolensk	1	RBMK-1000	1000	II	1982	2012	15-20

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