The nuclear legacy of the Russian Arctic
(status as of late 2023 and prospects for its elimination)
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The nuclear legacy of the Russian Arctic
(status as of late 2023 and prospects for its elimination)

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About Bellona:
The Bellona Foundation is an international environmental
NGO working on the major climate and environmental
problems. Founded in 1986 as a direct action protest
group, Bellona has become a recognised technology
and solution-oriented organization with offices in Oslo,
Brussels, Berlin, and Vilnius, and representatives in USA
and several EU Member States.

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Foreword

Since 1994, Bellona has not only observed and reported on the state of the Soviet nuclear legacy in Arctic regions, but has also provided assistance in eliminating sites and facilities that pose a hazard to the environment and human health, through a variety of available methods. Bellona’s activity in this field was initially one of the triggers that stimulated the European commission and the governments of a number of countries to take part in projects to eliminate “trouble spots” of the nuclear legacy, primarily on the Kola peninsula. Additionally, because Bellona is headquartered in Oslo, and because Norway shares a common border with Russia, our national environmental community has a special stake in the Arctic region — particularly in Severodvinsk, where construction and repair of nuclear vessels has led to the accrual of nuclear and radioactive materials.

Sunken nuclear and radiation hazardous objects in the Arctic seas — some of which were intentionally scuttled during the Soviet period — were of particular interest to Bellona and others following the collapse of the USSR.

It should be recalled that Bellona’s activity in the Arctic region began with a protest — a sea expedition in 1990 to Novaya Zemlya, where at that time underground nuclear tests were being carried out. Bellona was interested in bringing a stop them and understanding the nuclear prospects of this enormous archipelago located between the Barents and Kara Seas, adjacent to Norway.

The term “nuclear legacy” is a concept which has not yet been certified by Russian regulatory documents. When one speaks generally of the “nuclear legacy” in Russia, this means objects of the Soviet nuclear project which were created in the interest of the state, and which have not yet been eliminated. Therefore, among the objects of the nuclear legacy of the Arctic, besides those described above, it is justified to include, for example, the old units of the Kola NPP, the service period of which has now been extended to 60 years, as well as objects on the Novaya Zemlya archipelago and a number of smaller and less nuclear hazardous objects. This report does not contain a detailed description and analysis of these objects, as we will soon begin work on a separate working paper devoted to Novaya Zemlya and the Kola NPP. Furthermore, there are objects in the Arctic that are
awaiting a government resolution classifying them as part of the “nuclear legacy” — for example, places of “peaceful nuclear explosions”. Without a government decision, it is impossible to receive budget financing to eliminate these objects or to bring them into a safe condition.

The nuclear legacy in the Murmansk Region is unique because there was no other region in the world which had such a high concentration of decommissioned nuclear vessels which were essentially left at docks with nuclear fuel still in their reactors, or such a large amount of hazardous storage facilities of nuclear and radioactive waste. Bellona was especially concerned by the hazardous storage of spent nuclear fuel (SNF) at Andreyeva Bay, a former coastal maintenance base for the Soviet Northern fleet, where around 100 cores of nuclear reactors from various types of nuclear vessels had accrued over the years.

Over the last 25 years, Bellona has described in great detail the events taking place at nuclear legacy cites in the Arctic, preparing and publishing around 30 major reports and working papers, as well as several hundred articles on our website1.

From 2000 to the present, the governments of seven countries have taken part in projects to eliminate the nuclear legacy (Norway, the UK, Germany, Italy, Sweden, France, the USA), as well as political and financial institutions of the EU, such as the European Commission, the EBRD etc. Additionally, Finland, Canada and Japan took part in dismantling radioisotope thermoelectric generators (RITEGs) located on the near and distant Arctic coastline.

The situation for projects on eliminating the nuclear legacy changed after Russia invaded Ukraine on 24 February 2022. International donors who had been taking part in many projects to eliminate the nuclear legacy with finances, technologies and other resources withdrew.

Bellona reported on the pre-war situation and the state of nuclear legacy sites on the Kola peninsula in its working paper “Elimination of the nuclear legacy of the cold war”, published in early 20212.

In the present publication, Bellona surveys events in 2022-2023 at nuclear legacy sites in the Russian Arctic, and additionally evaluated their current state as of late 2023, and examines the prospects for bringing them into a safe condition. The information for this report was taken from official sources, the media, as well as materials from several events held in 2022-2023, organized by the Environmental solutions division of Rosatom. Bellona examined the tasks of the Environmental solutions division and Rosatom enterprises in its report “The Russian nuclear sector before and at the start of the war”3.

1  https://bellona.org/publications-and-archive
1. Andreyeva Bay

The last report with a survey of events relating to works in progress and the state of objects in Andreyeva Bay was published by Bellona in December 2019⁴.

Before the war, the governments of Norway, the UK, Sweden, Italy as well as the European Commission and the EBRD acted as investors in Andreyeva Bay on projects for bringing nuclear and radiation hazardous sites into a safe condition at various stages. After Russia’s invasion of Ukraine, all foreign investors withdrew from international projects ongoing at Andreyeva Bay, including European financial institutions and governments of member countries. Although Russia was left alone to deal with all the complex problems at the site, it was announced that work in Andreeva Bay for unloading spent nuclear fuel from units of dry storage facilities, and other works toward the final elimination of this site, would be continued⁵.

Treatment of spent nuclear fuel (SNF)

When the holdings of Andreyeva Bay were transferred to Rosatom (2000), the main volume of spent nuclear fuel was located in three dry storage containers (2-A, 2-B and 3-A), a small amount in separate containers, and several dozen hazardous spent fuel assemblies (SFA) in a former wet storage facility, where an accident took place in 1982 (building 5). According to the decision initially taken to eliminate the hazardous storage facility, all spent nuclear fuel from the above locations were supposed to be transported to the Mayak production association, as there is no other place in Russia for storing or processing SNF from transport reactors (including non-conditioned ones).6

According to Bellona’s assessments, since SNF began to be removed (on 14 August 2017), up until August 2023, from the containers 2-A and 2-B around 12,305 conditioned spent fuel assemblies and 50 non-conditioned assemblies were removed. This accounts for around 56% of the total volume. Over six years (2017-2023), SNF was transported by railroad 18 times from the storage site to Atomflot’s loading area, and from there to the Mayak production association. The dry storage unit 2-A was completely emptied of spent fuel.

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nuclear fuel. At present around 12,000 conditioned and non-conditioned SFA remain at the 2-B and 3-A dry storage units. It is difficult to predict how much time will be required to remove the remaining fuel assemblies, as removing unconditioned shells and fuel assemblies may require the use of unique — and therefore expensive — technologies that take a long time to develop.

For reference

All three dry storage containers in which SNF is stored were equipped from 1982-1986 and have identical construction. The internal diameter of the vessels is around 19 meters, and the depth is around 6 meters. Cells of vertically installed metallic pipes of around 325 mm are contained inside the vessels. The space between the pipes is filled with concrete. One thousand two hundred cells are contained in the containers 2-A and 2-B, and around 900 cells are kept in the 3-A container. The cells contain cases in which seven or fewer spent fuel assemblies are contained. A precise count of the loaded SFAs was not conducted. Thus, as of mid-2023 container 2-B contained around 4,500 SFAs, and container 3-A around 9,000 unconditioned SFAs — that is, around 46% of the total amount of SNF which was initially stored in Andreyeva Bay. At present, containers 2-A, 2-B and 3-A are in a shelter building (building 153) which was built in 2017.

According to a plan announced at a Murmansk conference by Rosatom representatives in July 2023, unloading and removal of the fuel from the containers 2-B and 3-A should be completed in 2029-2030. As stated above, SFAs from the 2-A container have been unloaded and removed to the Mayak production association, at least according to information provided by Rosatom. There is no plan for a final cleanup of the 2-A container, and there will likely not be one until unloading SFAs from containers 2-B and 3-A is completed.

Container 2-B still contains unconditioned SFAs, and its unloading continues. Precise timeframes for the unloading of this container have not yet been determined, as they may change for many reasons, primarily because of difficulties which in all probability will arise in unloading unconditioned SFRs from containers 2-B and 3-A.

Here it should be remembered that during the loading of SNF from building 5 into containers 2-B and 3-A, mainly non-conditioned (hazardous) cases containing damaged SFAs were
loaded. Additionally, the 3-A container was initially installed on a different horizontal line from containers 2-A and 2-B, which resulted in the need to carry out works to align biological protection elements (BPE) of container 3-A, thus allowing the use of the same loading machine for containers 2-A and 2-B. Work on BPE alignment was planned in 2022, but to date there is no information that this has been completed. Without completing works for BPE alignment, it will be impossible to unload SFAs from the 3-A container.

The technological process for preparing the 3-A cells for unloading SFAs involves five stages of consecutive and rather laborious and costly operations. Work for removing SFAs from the 3-A container will only begin if SFA unloading from the 2-B container is fully completed, and the reloading device will possibly be moved from the section above the containers 2-A and 2-B to the section above the container 3-A. Furthermore, works should be completed that involve all five stages of the technological process for preparing the 3-A container for unloading. At present, the Russian company Spetstekhkomplekt is carrying out work for the first stage of preparing the 3-A container for SNF unloading. The precise plan and schedule for these works are unknown.

The technological stages of unloading SFA from the 3-A container that have been announced look approximately as follows, in simplified form:

- unloading all conditioned SFAs from conditioned cases,
- unloading conditioned SFAs from unconditioned cases,
- unloading unconditioned SFAs from cases remaining in the container,
- unloading cases that can be extracted with jammed SFAs,
- unloading cases that cannot be extracted with jammed SFAs.

Taking into account the long-term and nearly criminal storage of SNF, and the fact that the nuclear fuel contained in container 3-A has an enrichment from 15% to 30%, it will be important to conduct work at all stages that would prevent possible nuclear processes from occurring; primarily, it will be necessary to remove water from cells, avoid seeping and thereby prevent conditions for a self-sustaining chain fission reaction and the formation of «nuclear flashes». Cases of nuclear hazardous situations arising are described in various documents (for example).

7 https://www.nrc.gov/docs/ML0037/ML003731912.pdf
Building 5 is a former SNF wet storage facility, where a radiation accident took place in 1982. Photo: RosRAO

Building 5

This facility, like all the other facilities of Andreeva Bay, was built by the military, and thus the quality of the buildings was questionable. The first section of the storage facility was put into operation in 1962, and the second in 1973. The structure of building 5 takes the form of four rectangular concrete ponds, two small ones each of which are 275 m³, and two large ones each with a size of 620 m³. Each pool was plated on the inside with carbon steel 3 mm thick with a polymeric coating.

Building 5 has eight sections: a service hall, a radiation control point, a transport corridor, two small pools for holding SNF, two large pools for holding SNF and a storage room for chains.

After the accident, all SNF stored there was loaded in an emergency mode into the three containers of the dry storage unit between 1983 and 1989. Bellona wrote about these events in detail in numerous reports, work documents and articles, for example here:

We should note that Building 5 is the only facility at Andreyeva Bay that has not been subject to any reconstruction or significant modernization. For over 20 years, Rosatom only worked at Building 5 on radiation monitoring, eliminating leaks, and minor repairs to individual rooms, the roof, foundation etc.

In 2003-2005, radiological studies of the service hall and containment pools were carried out, and measurements were made around the building. The radiation situation, especially inside the building, was and remains at a maximum unfavorable level, so all works carried out there are conducted by remote-controlled machines and robots.

As a result of studies carried out with the support of the EBRD, a large quantity of high-active and medium-active (around 35 m³ with a total activity of around 2,500 Curies) products of corrosion are located at the bottom of the four containment pools. These include some 400 objects classified as medium and high-active solid radioactive waste, six spent fuel assemblies and an unspecified quantity of fragments of core fuel rods. After Spetstekhkomplekt carried out work to extract six fragments of spent fuel assemblies from the right small pool in 2019, and in 2021 carried out a radioactive investigation, Rosatom announced that Building 5 had been moved to a nuclear-secure state (but not a radiation-secure state).
In December 2023, Rosatom announced that a plan for decommissioning Building 5 had been developed and approved. The goal of this approved plan is the complete liquidation of the facility. The liquidation of Building 5 is planned in stages. At the first preparatory stage, it is planned to remove operational radioactive waste, carry out a second engineering survey, develop and coordinate a project, and receive a decommissioning license.

At the second stage — which is the main one — it is planned to dismantle equipment and engineering systems, deactivate seven radiation-contaminated sections, demolish the building, excavate the foundation and radioactively contaminated soil, and fill in the foundation pit with clean soil. At the third and final stage, work is planned for improving the territory. The realization period of the stages and the final liquidation of Building 5 have not been determined.

9  https://www.atomic-energy.ru/interviews/2023/12/22/141775
The cost of all works for decommissioning, transporting, treating and burying radioactive waste in 2021 prices was assessed at around 2 billion rubles (around 23.3 million Euros).

Thus, nuclear legacy objects in Andreeva Bay remain one of the main problems for Rosatom in the northwest Russia, and they will require time, money and other resources for their elimination or eventual transfer to a safe condition. It is practically impossible to assess the cost of works. As an example Rosatom said in December 2023 that the cost of work to seal the radioactive waste burial site in Novouralsk — of a volume of 1,160 m³ — would be 320 million rubles (3.5 million Euros). However, if decommissioning Building 5 is assessed at 2 billion rubles, the cost of the final unloading of SNF from the dry storage facility in complex conditions, transport, processing and burying SNF and radioactive...
In summary, it is important to note several important facts and tendencies: Andreyeva Bay was initially the most hazardous and problematic object on the Kola Peninsula. Over the last two decades, many nuclear and radiation hazardous sections of Andreyeva Bay have been eliminated or brought to safe condition. Since the outbreak of the war, international projects have been suspended. The withdrawal of European countries and international financial groups from the project in Andreyeva Bay have led to a decrease in financial and technological resources, which at present are required primarily for removing SNF from the remaining dry storage facility containers, the decommissioning of Building 5 and other objects. It is unrealistic that under conditions of war and sanctions, the Russian government would be able to compensate for the international financial resources that have been withdrawn from the projects.

A list of what needs to be done to convert Andreyeva Bay into a “brown field” (as was planned initially) in our opinion looks approximately as follows:

• unloading the remaining SNF from the dry storage facility containers according to technology involving five stages (see the section Andreyeva Bay, treatment of SNF). Works on each stage require passing and introducing an unpredictable number of organizational, technical and technological solutions, which in turn will require many resources — that is, time and money.

• removing SNF via the route Andreeva Bay — Atomflot — Mayak production association. As some 70% of the remaining SNF is unconditioned, it will be necessary to solve tasks for manufacturing new containers (or adapting old ones) for this type of SNF. The experience of realizing these one-off orders shows that this is a rather expensive and slow procedure. Additionally, it should be considered that the sea transportation of SNF is only carried out by two vessels — the outdated and not particularly reliable Serebryanka and the newer Rossita, built in Italy and requiring spare parts that are not manufactured in Russia.
scrapping dry storage facility containers after SNF is unloaded from them. These containers are large and solid (metal, concrete, soil, etc.) radioactive waste of various levels of pollution, including the level of Russia’s first and second hazard class. Usually, this kind of work starts with developing a project, coordinating it, and preparing appropriate technical means, equipment and forces. At present no one is working on this problem — at least there is no information about this. No main concept has been announced (to say nothing of project documentation) about what will be done with all these remaining radiation hazardous storage facilities, structures and buildings, which are at present located at Andreyeva Bay.

there is no clarity or plan for the situation with Building 5. Information was given above about its state at present. Given that there is no coordinated concept for scrapping this object, we may assume that this process will be a lengthy one, and accordingly expensive and unsafe.

Thus, the former coastline maintenance base at Andreeva Bay remains a problematic site of the “nuclear legacy” of the Arctic, which will take at least 10-15 years to eliminate. At present, there is no plan to decommission all objects of Andreeva Bay and convert the territory to the level of a “brown field.” The volume of works and quantity of necessary resources to do this have not been determined, and accordingly there is no budget or even an understanding of where money can come from. Evidently, the information about plans, specific events and the progress of works carried out at sites will reach the public through the sieve of a propaganda filter by state and Rosatom media, which has essentially been the case for the last one and a half years. For Bellona, this has not come as a surprise, as in the late 90s Bellona employees began their work in Russia under approximately similar conditions.
2. Sunken nuclear and radiation hazardous objects

Nuclear and radiation hazardous objects were mainly sunk in the Arctic Seas in the Soviet period, and some in the post-Soviet era. Raising sunken objects and bringing them into a safe condition is a problem that is perhaps even more complex than converting Andreyeva Bay into a “brown field”. The process for eliminating objects in Andreyeva Bay with international cooperation had been set in motion and was close to the final goal. For the problem of raising sunken objects, in 2021, activity was observed at government level and within Rosatom, directed primarily towards solving organizational and financial issues.

On 15 April 2021, the Russian government approved the “United plan of events for realizing the strategy of developing the Arctic zone of Russian Federation and ensuring national safety for the period up until 2035”, decreeing the creation of a “roadmap” in the 2nd quarter of 2021 for raising and scrapping nuclear submarines K-27 and B-159 (decrees of the Government of the Russian Federation of 15.04.2021 № 996-p). According to the plan developed and submitted in late 2021 to the government by Rosatom, completion of works for raising nuclear and radiation hazardous objects in the Arctic Seas would be completed in 2035. This plan was made before the war and likely envisaged international participation in this project, including financing and technology.

Thus, in February 2023, Putin issued a decree “on changes to the strategy of developing the Arctic zone of the Russian Federation and ensuring national security in the period up until 2035”, postponing work to complete rehabilitation of territories containing sunken objects with spent nuclear fuel and radioactive waste, from the second stage for realizing this strategy (2025-2030) to the third stage (2031-2035). Therefore, even according to official plans, raising all objects will not be completed before 2035, provided there are no further delays or other decisions on raising objects. It should be noted that since the war began nearly all events concerning international cooperation and joint projects have been removed from Russia’s Arctic strategy and realization plan.

The budget application for financing works for raising objects that Rosatom submitted to the Finance Ministry will be examined in 2024. Rosatom expects that finances from a state program (the name is not revealed) may be used for this project, which will require around 22 billion rubles of state funds. Previously, in late 2021, Rosatom experts envisaged that the cost of raising the sunken nuclear submarines K-27 and K-159 from the sea bottom may come to more than 24 billion rubles.

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10 https://docs.cntd.ru/document/603336627
11 https://www.atomic-energy.ru/news/2021/10/01/117993
At the end of 2022, the options and technologies for raising sunken objects were discussed by specialists and experts at the Malakhit naval machine-building Bureau, the R&D institute for submarine technology, the Naval Academy and Rosatom. Russia lacks modern sea forces and means for raising sunken objects, and they must be created almost from scratch. The emergency rescue service of the Russian Navy, as the rescue operation of the Kursk submarine showed, is not capable of raising vessels. Therefore, it is proposed to raise vessels by an outdated method using cranes, catamaran barges or systems of cable jacks, large pincer grippers, two pontoons and a semi-submersible transport barge. These technologies have not been previously used for working with nuclear hazardous objects, so their suitability must be tested.
As such, according to official data, here are at present six objects sunken in Arctic Seas with SNF — five of which are in the reactor sections of the nuclear submarines K-19, K-11 and K-140 and in the sunken submarines K-27 and K(B)-159, and one reactor is sunk together with the screen assembly of the Lenin icebreaker (Table 1). Additionally, nine reactors are sunk with technological contents, but without nuclear fuel. In these regions, other solid radioactive waste was actively dumped, consisting of separate internal reactor structures, which were also formed in the process of operation, servicing and repair of nuclear objects. This category of radioactive waste included covers, screen assemblies, iron-water containment tanks, reactor control and protection rods, reactor vessels without internal contents, rags, filters, and many other metal structures, parts, and materials. In total, about 32,000 m³ of solid radioactive waste was sunk in the Arctic, including 17,105 containers and 18 small vessels. However, it is not a fact that this data is absolutely correct, as some witnesses (and even managers) of these past scuttling operations have made frank statements that the records concerning the amount of radioactive waste and the areas of sinking were often false.

The only nuclear hazardous object which accidentally (suddenly and without planning) sank in the Arctic seas is the submarine K-159, which lies at a depth of 170 meters at the entrance to the Kola Gulf near Kildin Island. At present no emission of radioactivity from the reactors of this submarine has been detected. However, it should be considered that this submarine was built almost 60 years ago and sank in conditions when this nuclear device with SNF in its reactors had not undergone special preparation for possible sinking. Thus, there are no grounds to expect that the constructive protective barrier will prevent radioactivity from spreading out of the reactor shell and the submarine over the course of a long period.

Experts from the Malakhit construction bureau (the designer of the K-27 nuclear submarine) believe that raising should take place soon, as the state of submarines is worsening, and raising may become so difficult that it will be less of a risk to leave the submarines on the seabed. Bellona experts do not see convincing proof of this position, but everything will depend on the raising technologies that are used. Nearly all experts agree that it is necessary to raise the K-27 submarine, which has highly enriched nuclear fuel loaded in its reactors. Experts continue to discuss the possibility (or impossibility) of a spontaneous chain reaction taking place if water gets into the reactors. In any case, even if a chain reaction does not take place, and the reactors are unsealed, the situation will be unpleasant, as highly active fuel located in its reactor will be washed away, with local pollution of the surrounding water. Therefore, from all appearances, if Russia starts to realize a project to raise sunken nuclear submarines, it must first and foremost raise the K-27.

The requirements, plans and options for the operation of raising has been discussed for almost 20 years, but at present the readiness of Rosatom and other structures that should be involved in the operation to rid the Arctic seas of nuclear and radiation hazardous objects remains practically zero.

12 https://www.atomic-energy.ru/news/2022/09/02/127773
Table 1.

<table>
<thead>
<tr>
<th>№</th>
<th>Object name</th>
<th>Location (all objects are flooded near the Novaya Zemlya archipelago)</th>
<th>Flooding Year</th>
<th>Depth (m)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Reactor compartment (RC) with two reactors of the nuclear submarine K-19</td>
<td>Abrosimov Bay</td>
<td>1965</td>
<td>20</td>
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<tr>
<td>2</td>
<td>(RC) with two reactors of the nuclear submarine K-11</td>
<td>Abrosimov Bay</td>
<td>1966</td>
<td>20</td>
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<tr>
<td>3</td>
<td>Port side reactor of nuclear submarine K-141</td>
<td>Novaya Zemlya depression</td>
<td>1972</td>
<td>300</td>
</tr>
<tr>
<td>4</td>
<td>Nuclear submarine K-27 (two reactors)</td>
<td>Stepovoy Bay</td>
<td>1981</td>
<td>33</td>
</tr>
<tr>
<td>5</td>
<td>The screen assembly of the Lenin icebreaker</td>
<td>Tsivolki Bay</td>
<td>1967</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>Nuclear submarine K-159 (two reactors)</td>
<td>near Kildin Island</td>
<td>2003</td>
<td>170</td>
</tr>
</tbody>
</table>

In completing the survey of sunken and submerged hazardous nuclear objects in the Arctic, it should be noted that discussions about whether these objects should be raised or not have not ceased, and continue at various levels. At all discussions that have taken place in Russia, the predominate opinion is that there was no sense in raising numerous containers with solid radioactive waste and separately sunken radioactive waste, as they presented practically no danger. Realistically, only the issue of raising objects with nuclear fuel was dealt with, primarily the K-27 and K-159 submarines. For the other “sunken objects”, it is only planned to carry out monitoring. The situation has been complicated by the fact that in Russia, these sunken objects have no “owner” — that is to say that there is no department to which these objects belong. For years, all departments of Russia refused to be the owner of such objects. This was one of the reasons why international organizations could not join or even initiate joint projects with Russia on raising these objects, as international partners were not certain which departments they should work with. At present, the Russian government has determined that the Rosatom (Atomflot) will be the main contractor of works with sunken objects in the Arctic — i.e. the owner of these objects — but so far there is no full understanding of how this will work.

Rosatom has persistently advocated for raising the K-27, with the reasonable motivation that Gremikha has a complex and infrastructure (which was financed by France), for unloading fuel from the K-27 reactor. As for the K-159 submarine, this was primarily a “disgrace of the navy,” which wanted to wash its hands of the incident by raising the wreck. Secondarily, the region of the wreck and the state of its reactors, which were unprepared for submersion, present a danger for international shipping and fishing.

At present, discussions about whether to raise or not to raise the objects continue. There are the political decisions which were discussed above, but there are no approved projects, technologies or means for raising — and no money has been allocated specifically for these purposes. Therefore, according to Bellona experts, sunken nuclear hazardous objects in the Arctic will remain where they are for the foreseeable future.
The nuclear legacy of the Russian Arctic
(status as of late 2023 and prospects for its elimination)

3. Gremikha

The SevRAO Gremikha division was established on the site of coastal maintenance base 574 of the Northern Fleet in 2000. The main tasks facing the division were:

1. Handling radioactive waste and radioactive substances;

2. Handling spent nuclear fuel (SNF) stored at the unit;

3. Rehabilitation of the territory contaminated with radioactive substances.
In 2022-2023, works on dismantling two cores of liquid metal reactors of the 705-project nuclear submarine were carried out. Additionally, in 2022, dismantling and unloading of two spent removable parts of the core of the Sosnovy Bor stand (“Product 64”) commenced. It is planned to complete this work in 2024.

In Gremikha, because of operations to unload and dismantle the spent removable parts of submarine cores, a large amount of high-level radioactive waste (HLRW), including control and protection system (CPS) rods, as well as medium-level and low-level radioactive waste was accumulated. In 2025-2027 it is planned to place accumulated HLRW in containers and remove them for storage in the Saida regional center of conditioning and long-term storage. “Historical” solid radioactive waste accumulated because of unloading of pressurized-water reactors of nuclear submarines was transported from the storage facility and temporary storage sites to Saida in 2018.

In addition, decommissioning of radiation-contaminated facilities which are not planned for further use and rehabilitation of their territory are planned for 2024.
Thus, the work in Gremikha on unloading of spent removable parts from the 705-project nuclear submarine and the removal of spent nuclear fuel from pressurized-water reactors is planned to be completed in 2024-2025. However, Rosatom is interested in preserving and using the dock, infrastructure, and equipment of the entire complex for unloading spent removable parts from liquid metal reactors for the possible scrapping of the K-27 submarined, if it is raised.

Financing the complex for unloading spent removable parts was carried out by France and other European donors (CEA, EBRD, EC).

In summarizing the brief survey of the present situation, it should be noted that the former nuclear submarine base in Gremikha (now «Gremikha SevRAO Division») with all its structural facilities has always been something of a mystery for the public. Bellona has visited nearly all the nuclear heritage sites of the Kola Peninsula — except for Gremikha. The problem was not only the poor and limited possibilities of transportation connecting this base with cities in the Murmansk or Arkhangelsk regions, but also the fact that Gremikha has traditionally been closed to prying eyes. The old nuclear submarine base — especially the onshore technical base with its half-destroyed storage facilities — and other sites were not shown to the public, official delegations and foreigners. Therefore, all information that the public (including Bellona) has concerning this facility is taken from the media or from reports at events organized by Rosatom.

Bellona estimates that the facility at Gremikha will remain until the issue of raising the K-27 nuclear submarine is resolved positively (or negatively). After that, work will begin on converting the site to a «brown field» or other condition. The question of when and how this will be done remains open, as there is no concept or plan. The submarine base (3rd and 41st divisions, 11th nuclear submarine flotilla) was officially disbanded and closed in 1995. The settlement Jokanga (Closed administrative-territorial entity Ostrovnoy), where submariners and part of the local civilian population lived, fell into disrepair and most inhabitants moved away. Life in Gremikha is maintained only through the operation of a small Rosatom structure, Gremikha SevRAO Division. With Rosatom’s departure, Gremikha will cease to be a «nuclear legacy» site.
In Saida Bay, a regional center for conditioning and long-term storage (CCLS) of radioactive waste has been established. The CCLS has two sites — a facility for long-term storage of radioactive sections and a site for conditioning and long-term storage of radioactive waste.

The first facility was built from 2004 to 2011, and the second was completed in 2015.

Currently, the CCLS complex is used for conditioning and long-term storage of reactor compartments of scrapped nuclear submarines, blocks with compartments of nuclear-powered nuclear service ships, surface ships with nuclear power units, nuclear-powered icebreakers, as well as radioactive waste from enterprises of the North-Western region of Russia that are engaged in scrapping nuclear submarines and nuclear fleet ships, rehabilitation of former coastal technical bases, as well as radioactive waste generated in the section for the formation and maintenance of blocks and secondary radioactive waste during the operation of the complex.
The projected capacity of the CCLS provides for the storage of 160 nuclear submarine blocks, 14 units from floating technical bases (FTBs), and 4 units from surface ships. As of the end of 2023, 123 blocks from reactor compartments of nuclear submarines and 12 block packs of service vessels and three block packs from the nuclear icebreakers “Sibir” and “Arktika” were stored in Saida Bay. At present, the CCLS site in Saida Bay is 80% full. Rosatom plans to send nine more reactor compartments from nuclear submarines, two block packs from the nuclear icebreakers “Rossiya” and “Sovetsky Soyuz”, and three block packs from maintenance vessels to the CCLS site over the next few years (it is not known exactly when).

At the CCLS complex, radioactive waste is stored in five compartments of the storage unit:

- compartment 1 — conditioned combustible solid radioactive waste,
- compartment 2 — conditioned non-combustible solid low-level radioactive waste
- compartment 3 — conditioned solid medium-level radioactive waste and high-level radioactive waste,
- compartment 4 — conditioned metal bulk low-level radioactive waste, HLRW and CPS rods,
- compartment 5 — conditioned metal low-level radioactive waste.
The planned capacity of the storage facility is 100,000 m³ of radioactive waste, and the planned operation period for radioactive waste (including all reactor compartment units and unit packages) is 100 years. Operation means all activities involving radioactive waste (conditioning, maintaining and dividing radioactive waste, filling storage compartments). According to the latest information, the Center will process 1168 m³ of waste in 2021, 944 m³ in 2022, and about 1000 m³ in 2023. There is no information on how much waste is currently stored at the CCLS, but it should be noted that some waste is periodically exported outside the northwestern region of Russia to disposal sites, which are owned by the National Operator for Radioactive Waste Management.

To conclude this brief overview of the facility, we should note that the Saida CCLS is one of the successfully completed projects for dealing with the Soviet nuclear legacy in the Arctic zone. Bellona believes that the reason for this success is that Germany financed the project and German engineers managed the construction at Saida, using German technology and following German regulations. It should be recalled that before the creation of the site for long-term storage of reactor compartments, before 1990 there was a fishing farm in Saida and there was no nuclear legacy on this territory. Since 1990, the Northern Fleet has used old piers for the three-point units of scrapped nuclear submarines (which included the reactor compartment) and piers that were specially towed to Sayda from other bases of the Northern Fleet. The issue of creating a facility to dispose of the accumulated Soviet legacy arose in 2000, when the reactor compartments of scrapped nuclear submarines began to accumulate in large numbers and the risk of their flooding increased. Germany then came to the rescue, creating virtually from scratch the present-day modern complex for long-term storage of the Soviet nuclear legacy. It is envisaged that the CCLS will operate for at least 50 to 80 years longer, until all the reactor compartments that have accumulated to date are dismantled. During this time, at least one important issue will have to be resolved — the creation of a radioactive waste disposal facility in the northwestern region of Russia, to which accumulated waste from the Saida CCLS can be transported, rather than shipped to other regions.
The nuclear legacy of the Russian Arctic
(status as of late 2023 and prospects for its elimination)

5. Atomflot

FGUP Atomflot was transferred from the Murmansk Shipping Company to Rosatom in 2008. At the end of 2023, Atomflot had 32 nuclear and radiation hazardous vessels: eight nuclear-powered vessels (the nuclear icebreakers “Sibir”, “Arktika”, “Ural”, “50 Let Pobedy”, “Yamal”, “Vaigach”, “Taimyr”, the nuclear-powered lighter carrier “Sevmorput”), five nuclear support vessels, and 19 other vessels and watercraft. It is difficult to say whether this entire fleet can be classified as what we define as the «nuclear legacy». Neither the public nor Rosatom experts and bureaucrats are clear about this, since there is no precise list of objects that are classified as nuclear legacy. Everything depends on
The nuclear legacy of the Russian Arctic
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when these vessels were built, as well as who will pay to scrap these ships and on what principle; if this is financed by the budget with small extra-budgetary additions, then vessel can be considered nuclear legacy objects; if this is only financed by Rosatom or foreign foundations, then the question remains open.

In addition, onshore nuclear and radiation-hazardous facilities are located on the territory of Atomflot:

- A container-type storage for spent nuclear fuel of the icebreaker fleet.
- A coastal Loading Station for loading shells containing spent nuclear fuel into transportation containers.
- An accumulation site for temporary storage of transportation containers with spent nuclear fuel from the Navy. The site is used to load the container wagon of the train that transports spent nuclear fuel for reprocessing to the Mayak production association.
- Liquid radioactive waste storage facility (LRWSF).
- Temporary storage facility for conditioned radioactive waste.

Work on eliminating the nuclear legacy mainly involves decommissioning nuclear icebreakers and nuclear service vessels at the end of their service period, which were built mainly in the Soviet era. From 2016 until the present, scrapping has been carried out on the “Arktika” icebreaker, which was built in 1972. The start of work on scrapping the nuclear-powered icebreakers “Rossiya” (launched in 1985) and “Sovetsky Soyuz” (launched in 1986) is planned for 2027.

In 2023, Rosatom widely (even grandiosely) celebrated the completion of the project for scrapping the Lepse floating maintenance base. In terms of improving nuclear and radiation safety in the Murmansk region, this is indeed an important event. The project to scrap the Lepse base lasted almost 30 years and cost about 60 million Euros. Of this, 55 million came from the EBRD\(^{13}\), 2.5 million Euros from Norway\(^{14}\), and the rest of the money evidently came from Russia. The project was launched in 1994, when Bellona organized a conference at the Murmansk Shipping Company (at that time the Lepse base was under its management) on board the nuclear icebreaker “Sibir”, inviting European officials,

\(^{13}\)https://www.atomic-energy.ru/news/2023/11/24/140893
representatives of the Norwegian government and other officials on whom the possibility of financing the scrapping of this dangerous facility depended. Throughout these 30 years, Bellona repeatedly returned to the topic of the Lepse base in its reports, working papers and articles\(^\text{15}\) and believed that it had made a major contribution to getting the project realized. But it did not take part in the celebrations to mark the end of the project, as Bellona was declared an undesirable organization in Russia, and its offices in Murmansk and St. Petersburg were closed. In addition, Bellona decided to suspend business and other contacts and cooperation with state organizations and their representatives because of their active support of the war in Ukraine.

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Project for scrapping the Lepse floating maintenance base. towing from the berth of the Federal State Unitary Enterprise "Atomflot". 2012
Photo: Bellona Archive

\(^{15}\) https://bellona.ru/publication/lepse-istoricheskij-put/
6. Ship repair and shipbuilding yards

There are four enterprises located on the Arctic coast that carry out construction, repair, decommissioning and dismantling of nuclear-powered ships of various purposes belonging to Atomflot and the Russian Navy.

Two plants (the SMP and Zvezdochka) are located in Severodvinsk and two (the Nerpa Shipyard and the 35th Shipyard) on the Kola Peninsula. Nuclear and radiation-hazardous activities at these plants began at the time when the Soviet Union started building nuclear ships, so it is understandable that the territories of these plants have accumulated their own nuclear legacy, mainly in the form of old storage facilities for liquid and solid radioactive waste. As a rule, nuclear waste (SNF) at these plants is only subject to short-term storage, so there are no such emergency storage facilities on these territories like
in Andreyeva Bay or Gremikha. The storage facilities that remain at the plants today can hardly be categorized as the «nuclear legacy». The enterprises have removed all Soviet-era radioactive waste for reprocessing and conditioning or to new temporary storage facilities (e.g., in Saida).

It should be noted that there are almost no nuclear legacy objects left at the Atomflot, ship repair and shipbuilding plants following the scrapping of the Lepse base. It should be considered that Atomflot was founded in the post-Soviet period. Therefore, Atomflot’s facilities, except for several old floating maintenance bases, such as the “Imandra” and “Lotta” bases, and the “Serebryanka” and “Volodarsky” tankers, are difficult to classify today as objects of the Soviet nuclear legacy.

Launching the new strategic nuclear submarine «Yury Dolgoruky» at the Sevmash shipyard.
Iliya Pitalev / RIA Novosti / commons.wikimedia.org
Conclusion

The Arctic nuclear legacy mainly consists of the old nuclear-powered navy and its basic infrastructure, which began to be transferred from the Russian Navy to Minatom (now Rosatom) in 1998. Therefore, initially the elimination or transfer to a safe state of these facilities was not a priority for Rosatom and its management, as this task was not previously its responsibility. Rosatom’s subsequent interest and activity was triggered by international decisions at a high political level and the possibility of obtaining foreign funding to solve the problems that arose. In particular, the trigger for the Arctic cleanup projects was the meeting of the G8 (the seven most economically developed countries of the world and Russia) in Kananaskis (Canada) in June 2002, where it was decided to allocate USD 20 billion to finance a ten-year program to scrap Russian weapons of mass destruction, including nuclear submarines.

Since the Russian invasion of Ukraine, the political and economic situation has changed, and so Bellona believes that for the next 10-15 years the Arctic will remain a nuclear region with the objects of the nuclear legacy mentioned above, as well as some others. It is practically impossible to eliminate these facilities or even to bring them to the safest possible state in the current unfavorable geopolitical and economic conditions that Russia faces.

Interrupted communications can have a negative impact not only on the level of nuclear and radiation safety, but also on the openness of information and, consequently, on the possibility of public influence and control over what happens at nuclear legacy sites. Already now there is a return to restricting information. As an example, in 2022 and 2023, the conferences in Murmansk and St. Petersburg, where the problems of «nuclear legacy» in the Arctic were discussed, mostly consisted of cheerful reports about what had been done before the war and unsupported promises that nothing had changed and vows that everything would continue as it had before. Not a single public event in 2022-23 presented any real analysis of the situation or any specific data reflecting the changed conditions, to say nothing of plans, forecasts, calculations or real prospects. One gets the impression that the goal is to pretend that there is no war and that nothing has happened or changed.
In concluding the review of the situation surrounding Arctic nuclear legacy sites, several factors should be mentioned, including those that have been particularly noticeable since the outbreak of war.

Owing to the current military and political situation, since February 2022 the task of eliminating the nuclear legacy has not been a priority for Russia, and consequently not for Rosatom either. Presenting the results for 2023, Rosatom Director General Aleksei Likhachev noted the main priorities in Rosatom’s activities were the defense order, power generation in Russia, construction of NPPs abroad, as well as import substitution and new products. Environmental tasks were mentioned only in connection with the program imposed on Rosatom for the liquidation and processing of non-radioactive waste of hazard classes 1 and 2, and the liquidation of a number of significant facilities (BPPM, Usolie-Sibirskoye, Krasny Bor), which is proceeding under the national program «Ecology».

Bellona has written about these facilities in numerous reports, starting, for example, with this one16. However, judging by the propaganda campaign for this area of Rosatom’s activity, there cannot be full confidence in the success of these projects in the present situation. In addition, all reports endlessly present the scrapping of the Lepse base as a great success by Rosatom, although, as emphasized above, it was a long-suffering project that took almost 20 years and 64 million Euros to implement.

Starting from about 2020, funding for the main federal program for decommissioning and eliminating the Soviet nuclear legacy and the targeted program for scrapping nuclear submarines has been reduced. Only continuous international funding has allowed the projects in Andreyeva Bay, Gremikha, and other sites mentioned above to move forward.

Since the war began, international cooperation and funding for eliminating the nuclear legacy has ceased. This will cause these projects to slow down or be suspended indefinitely, leading to unpredictable occurrences of nuclear and radiation risks.

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