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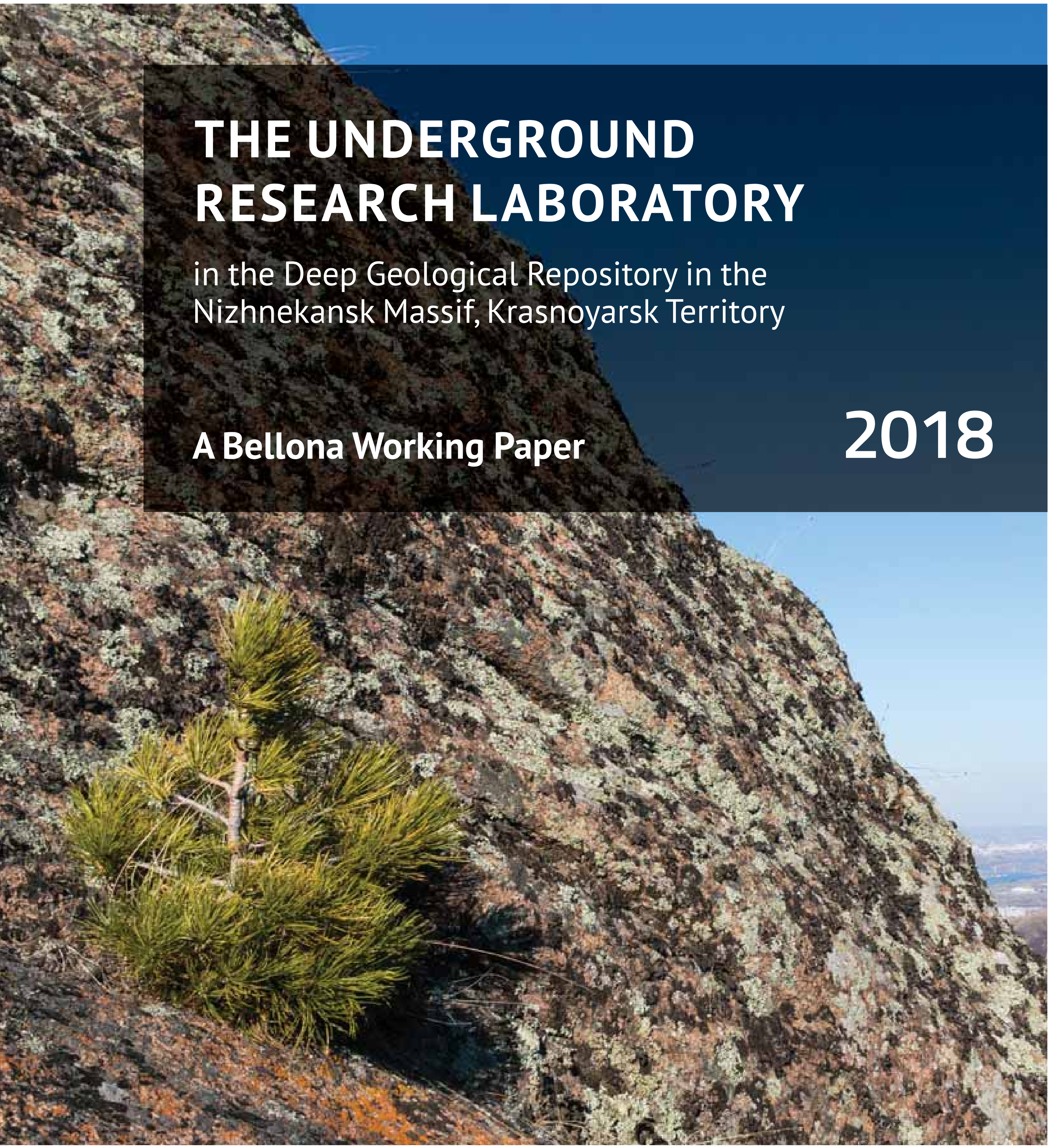
THE UNDERGROUND RESEARCH LABORATORY

in the Deep Geological Repository in the Nizhnekansk Massif, Krasnoyarsk Territory

A Bellona Working Paper

2018



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List of Terms and Abbreviations

HRW	high-level radioactive waste (high-level waste and intermediate-level waste)
MCC	mining and chemical combine
SNF	spent nuclear fuel
DGR	A deep geological repository for radioactive waste, including a facility located at a depth of more than 100 meters.
RWSF	radioactive waste storage facility
URL	An underground research laboratory: an underground facility that in terms of design, construction, and placement corresponds to a DGR and is intended for research towards its construction.
RW	radioactive waste
DCS	disposal canister shaft
SMP	strategic master plan: a comprehensive research program in support of constructing a safe, long-term radioactive waste disposal facility (including a general URL research program) and optimization of the facility's operational parameters.
Gneiss	A metamorphic rock mainly composed of plagioclase, quartz, and potassium feldspar (microcline or orthoclase).
Granitoids (granitic rocks)	The generic name for a group of plutonic and, more rarely, metasomatic rocks with a silicon dioxide content of over 62%.
Dikes	A sheet of rock that is formed in a fracture in a pre-existing rock body. Magmatic dikes form when magma flows into a crack, then solidifies as a sheet intrusion, either cutting across layers of rock or through a contiguous mass of rock.

Preface

The decision has been made to build an underground research laboratory (URL) to support construction of a deep geological repository for radioactive waste (DGR), including confirmation of its long-term safety and the suitability of the chosen building site.

Russia has joined those countries who argue that radioactive waste (RW) should be buried in deep geological strata situated in areas of granitoid. Most of these countries (five out of nine: Canada, Sweden, Switzerland, Japan, and Finland) are engaged in research aimed at establishing radioactive waste storage facilities in granite (see Table).

Facility Name	Country	Geology	Depth (in meters)
AECL	Canada	Granite	240–420
Äspö	Sweden	Granite	450
Asse	Germany	Salt massif	490–950
	France	Claystone	445–490
Gorleben	Germany	Salt dome	900
Grimsel	Switzerland	Granite	450
HADES	Belgium	Plastic clay	230
Horonobe	Japan	Sedimentary rock	140–250
Kamaishi	Japan	Granite	300–700
Mizunami	Japan	Granite	300
Mont Terri	Switzerland	Claystone	250–320
Morsleben	Germany	Salt dome	500
Olkiluoto	Finland	Granite	500
Onkalo	Finland	Gneiss	455
Stripa	Sweden	Granite	360
Tono	Japan	Sedimentary rock	150
Tournemire	France	Claystone	250
WIPP	USA	Salt bed	655
Yucca Mountain	USA	Ignimbrite	300

Russia started conducting this research later than the other countries. This is not very good, of course, but at the same time Russian can benefit from their know-how and not make the mistakes they have made. Russia also has its own know-how when it comes to strategic planning, for example, involving the decommissioning of the nuclear submarine fleet in Northwest Russia and solving the problems caused in the Techa River Basin by the Mayak Nuclear Plant. Therefore, when considering the project for constructing the DGR in the Nizhnekansk Massif, the decision was made to draft a strategic master plan (SMP) for a research program in support of constructing a safe, long-term DGR and URL, and optimizing the facility's design and operational parameters.

As always, public reaction to construction of the URL, first, and then the DGR, has been mixed. On the one hand, there is a general understanding that radioactive waste, especially high-level waste, must be transferred to a safe place. On the other hand, society has countermeasures at its disposal, arguments and questions it drags out time and again. For example, the facility should be built elsewhere, not near us. The facility is a threat to people and the environment, and there is no proof that someday it will not turn into another Chernobyl. What benefits will the facility bring to people in the surrounding towns? Finally, we want to know everything and have total oversight of the whole thing.

The management and disposal of HRW will always be a matter of public concern. The professional community is thus tasked with informing stakeholders in a way that makes sense not only to specialists but also to the general public. At the same time, the information must be accurate.

This working paper provides a brief overview of numerous official documents, scientific articles, reports by research institutes, and other printed matter concerning construction of the RW disposal facility. The paper summarizes research plans in the coming decades, as well as the viewpoint of independent experts who disagree with Rosatom's experts on the strategy for disposing of RW and the choice of the site for constructing the URL and, possibly, the DGR. The working paper's objective is to inform the public of what work and research was carried out before the decision to build an underground research laboratory was made.

This paper has been published at www.bellona.ru and on other websites.

I. Regulatory and Legal Framework for Constructing the URL

Federal Law No. 190 (hereafter, "FL 190"), "On Radioactive Waste Management and Amendments to Certain Russian Federal Laws," was passed on July 11, 2011.

FL 190 stipulates radioactive waste must be deposited in RW disposal sites. The law further clarifies that "RW disposal" means safely disposing RW in a RWSF with no intention of extracting it later.

The law spells out that solid long-lived high-level and intermediate-level RW must be disposed in deep disposal sites that localize the waste. It also defines a deep geological repository (DGR) as radioactive waste facility situated at a depth of more than 100 meters below the earth's surface.

FL 190 thus clearly stipulates that solid long-lived high-level and intermediate-level RW is subject to mandatory disposal in a DGR that includes a facility situated at a depth of more than 100 meters. This means that, currently, NO RAO (National Operator for Radioactive Waste Management) has no other options for disposing long-lived high-level and intermediate-level than in DRGs.

On November 19, 2012, the Russian federal government adopted Resolution No. 1185, "On Defining the Procedure and Schedule for Organizing a Unified Federal Waste Management System," which stipulated the commissioning of a URL for researching and confirming the feasibility of building a DGR.

On November 19, 2015, Russian Federal Government Resolution No. 1248 approved the Federal Targeted Program "Maintaining Nuclear and Radiation Safety, 2016–2030." The program provides for "construction of a high-level and intermediate-level RW isolation facility (Nizhnekansk Massif, Krasnoyarsk Territory)" (Paragraph 2.1), including a first stage in the form of an underground research laboratory.

II. Historical Background: Site Selection and Decision to Build URL

Choosing a place to build an underground RW disposal facility became a matter of urgency when officials realized the amount of HRW and the means of its disposal—in obsolete interim facilities at the Mayak Nuclear Plant, the MCC in Zheleznogorsk, the Siberian Chemical Combine in Seversk, and other Rosatom enterprises—required a more radical and safer solution.

In 1993, the search began for geological formations and sites for building an underground facility for disposing of solid HRW from the MCC. The work was undertaken by specialists from the Russian Academy of Sciences, geological organizations in Krasnoyarsk Territory, and other organizations contracted by the Russian Atomic Energy Ministry. It was supervised by the Khlopin Radium Institute in Petersburg.

The search area originally covered the boundaries of three major geological formations: the Siberian Platform, the Western Siberian Plate, and the Altai-Sayan Belt (Figure 1).

Figure 1. **Area of the Siberian Platform, Western Siberian Plate, and Altai-Sayan Belt**

Analysis of data on geology, tectonics, seismic activity, environmental management, and the social and economic aspects showed that the ancient igneous and metamorphic formations of the South Yenisei Ridge, a peripheral projection of the Siberian Platform's crystalline basement, were the best fit for the project's geological concept and criteria.

Promising areas were identified within the South Yenisei Ridge, including the northern part of the Upper Proterozoic Nizhnekansk Granitoid Massif. Eighteen potential sites in the Nizhnekansk Massif were preliminarily identified within a 100-kilometer radius of the MCC. Comparative assessments of the sites produced a list of five promising sites: South, Upper Itatsky, Lower Itatsky, Telsky, and Yenisei. Each of these five sites was then subjected to preliminary comparative safety assessments on the basis of mathematical models and baseline date from archived samples. Consequently, a few very promising sites were identified: Upper Tatsky (Kamenny and Itatsky) and Yenisei, where comprehensive engineering and geological surveys were undertaken, involving the drilling of deep exploration shafts.

The Yenisei site was recommended on the basis of geological surveys carried out between 1993 and 2007, and a comprehensive comparative analysis of the rock mass in connection with geographical and economic conditions for subsequent research aimed at constructing a HRW final isolation site and URL.

Complex geophysical research on the surface of the Yenisei site was carried out between 2002 and 2005, first in an area of seventy square kilometers, then, in more detail, in an area of twenty-five square kilometers, as well as geological exploration involving drilling and core sampling in three shafts 100 meters deep and one shaft 600 meters deep. Samples of rocks and groundwater were tested in laboratories.

In 2008, a declaration on construction of and HRW final isolation facility in the Nizhnekansk Granitic Gneiss Crystalline Massif (Yenisei Ridge) was adopted.

To date, the site has been selected, the design of the facility has been presented, and the issue of building the URL as the first phase in constructing an HRW final isolation facility has been resolved.

III. Brief Overview of the Nizhnekansk Massif and the Yenisei Site

With a total area of 3,500 square kilometers, the Nizhnekansk Massif is one of the largest in Central Siberia. The northern part of the massif consists primarily of denudation plain, modified by a well-developed river network.

The ground water supply is low, less than ten percent.

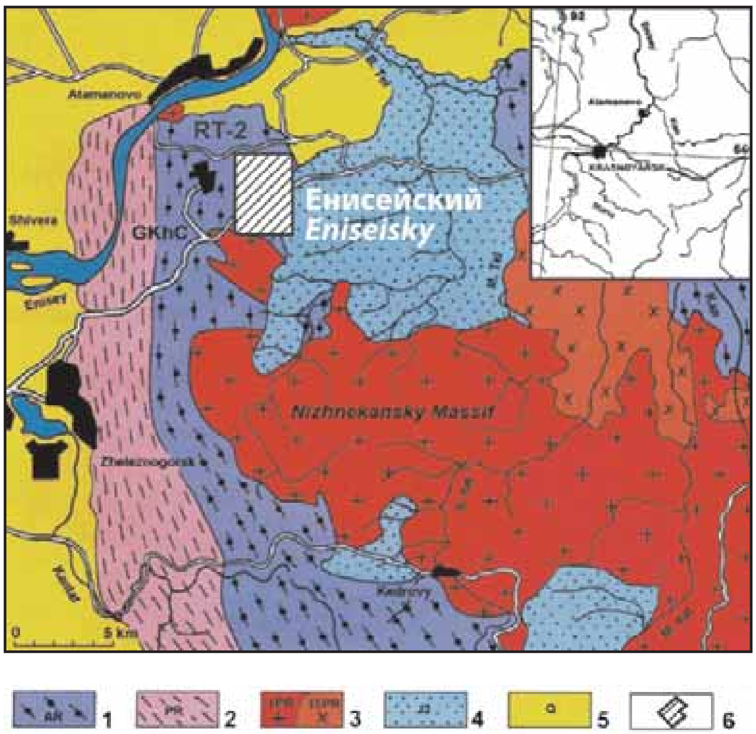

Figure 2. **Geological map of the area of the MCC and the Yenisei Site. 1 – gneiss complex; 2 – gneiss-shale complex, featuring amphibolites, marbles, and quartzites; 3 – granitoids of the Nizhnekansk complex (1 – granites and leucogranites; 2 – diorites and granodiorites); 4 – sedimentary rock complex; 5 – Quaternary sediments; 6 – Yenisei site.**

The right bank of the Yenisei River consists of forested low-mountain topography. The basins of its tributaries, especially the lower reaches of the Big and Little Telya Rivers, are leveled boggy valleys.

The area has a distinctly continental climate, featuring long, harsh winters and short, hot summers. The average annual temperature varies between +0.5 and –3 °C. The average temperature in January ranges from –20 to –22 °C, while in July it varies between +15 and +20 °C. Annual precipitation is between 540 mm and 560 mm. Precipitation between November and Marches varies from 130 mm to 160 mm, while it ranges from 390 mm to 400 mm from April to October. The rivers are fed by melting snow in the spring, and rainfall in the summer and autumn.

The Nizhnekansk Massif is located in the continental region of the temperate climatic zone. Its topography is typical of the earth's surface as a whole: a combination of slopes of varying steepness, shaped by tectonic uplift and hydraulic erosion. The Yenisei and the Kan are the main rivers delimiting and shaping the watershed in the massif's northern reaches. The watershed contains a network of small draining rivers.

The studies conducted between 1993 and 2005 led to the identification of Site 37 within the Yenisei site. Site 37 was subjected to detailed engineering and geological surveys, which focused on the feasibility of building a final isolation facility for conditioned HRW. Site 37 is located four kilometers from the MCC and 4.5 kilometers from the Yenisei, in the closed town of Zheleznogorsk, formerly known as Krasnoyarsk-26 (Figure 3).

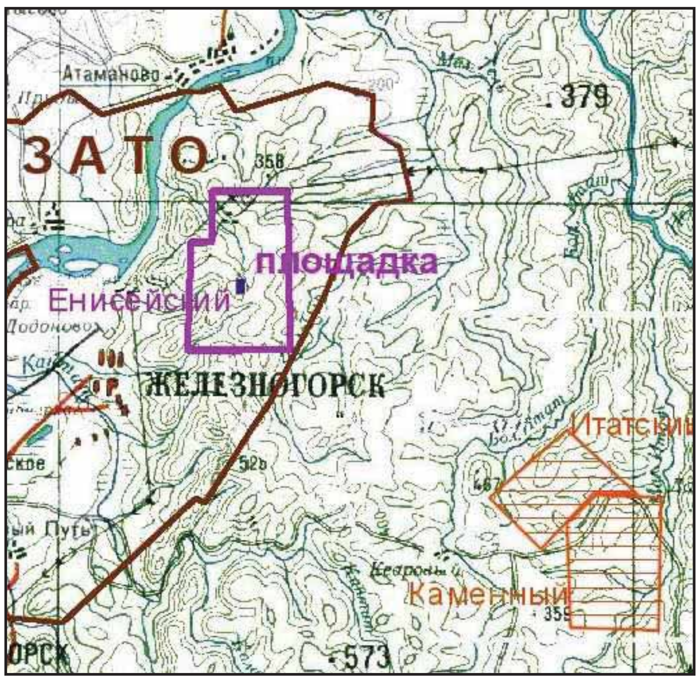

Figure 3.* Location of the Yenisei site and Site 37, the proposed location of the RW *disposal facility

Tectonic Description of Site 37

The site is located in a block of relatively homogeneous rock measuring four kilometers by five kilometers, delimited on three sides by third-order detachment faults. The detachment faults attenuate at lower depths. They are characterized by low-contrast anomalies, which testifies that they have been filled in by dikes and there is no tectonic activity at present.

No sources of ascending brines and other indications of discharge from deep layers has been found at the Yenisei site. The site is dominated by the downward filtration of groundwater. A helium survey confirmed the conclusion that upward filtration of fluids from deep layers is absent at the site.

The rocks at the depth where the underground facilities are planned are more than 1.8 billion years old, while the groundwater at depths below 200 meters is around 7,000 years old or older.

The rock mass in the area of the Yenisei site is typified by a stable tectonic regime, as confirmed by field observation of topographic layering, an analysis of topographic maps, and geodetic measurements of vertical crust velocity. The average rate of uplift in the area over the last five million years has not exceeded .08–.09 mm per year (i.e., up to nine meters per 100,000 years), and the rate has been even less at sites within the area.

Observations and calculations indicate extremely low rates of recent and current tectonic movements in the mass, corresponding to the platform type of development and its slight tectonic activity. Considering the research findings, the base of the bloc where the recommended site is located is an intrusive mass, detached, according to the geophysical findings, at a depth of 1,500 meters and considerably more sizable than the area required by the facility. The preliminary estimate is that the underlying intrusive mass is approximately sixty square kilometers in area, while the recommended area for the facility is less than one square kilometer.

Potential tectonic shifts will subject construction of the planned facility to significant burdens, since any tectonic stress that arises is discharged along the edges of stable environments, in this case, along the fissures surrounding the intrusive mass of hard rock.

Thus, to date, complex geophysical works have been conducted on the surface. Twenty exploratory shafts have been used to carry out geological and geohydrological studies of the rock mass to a depth of 700 meters. The studies featured complete core sampling and a battery of geophysical, experimental filtration, and lab tests.

The venue selected at the Yenisei site meets the following criteria, as determined by the regulations governing safety requirements.

- The site is not located in an area that experiences active movements of the earth's crust, high levels of seismic activity, and intense tectonic shifts.
- The enclosing rocks are crystalline igneous or metamorphic rocks. They have favorable physical and mechanical characteristics, homogeneous structure, and low fissility.
- The groundwater is slightly alkaline, poorly mineralized, and deoxidizing.
- There are no active faults in the site.
- The site is large enough to accommodate all the facilities.

IV. Strategy for Constructing the DGR

On March 28, 2018, Rosatom's director general approved the strategy for constructing a HRW DGR. The corresponding document reflects Rosatom's visions of the possible conditions involved and methods used in building such a complex facility as a DGR.

The strategy document envisions implementing the project in phases between 2017 and 2030.

Phase 1: Preparatory Work Towards Building the URL. Duration: up to five years (between 2017 and 2021, approximately). The first phase of the project involves:

- developing and approving a SMP for long-term security;
- elaborating a research program for the URL and a comprehensive monitoring program;
- updating the disposal concept;
- fine-tuning the design plans and specs for the URL and DGR;
- building and bringing online auxiliary surface facilities (i.e., a power station) for the URL;
- commissioning hydrological, hydrogeological, geodynamic, seismic and radiation monitoring systems;
- organizing and holding the first international conference on the problems of building and securing a DGR in the Nizhnekansk Massif.

Phase 2: Building the Demonstration and Research Center and URL. Duration: up to five years (between 2021 and 2025, approximately. The second phase of the project involves:

- building a demonstration and research center on the surface;
- designing a detailed research program for the URL (rationalizing all its goals and the conditions in which experiments are conducted, and predicting outcomes for the next ten to fifteen years);
- rationalizing long-term safety criteria for accepting RW, and updating the disposal concept;
- bringing the demonstration and research center and URL online;
- launching individual experiments in the URL;
- producing shafts, bores, and crosscuts for the URL;
- opening an info center in Krasnoyarsk;
- submitting a long-term safety case to international experts.

Phase 3: Operating the Demonstration & Research Center and URL. Duration: five years or more (from 2025 to 2030, approximately). The third phase of the project involves:

- summarizing research outcomes and updating the disposal concept;
- operating the URL and implementing the comprehensive monitoring program;

- developing quality assurance programs in accordance with RW disposal acceptability criteria;
- public oversight of the facility's safety.

Phase 4: Decision-Making on Possible Construction of DGR, Licensing Construction of DGR, and Constructing the First Stage of DGR. Duration: five years or more (from 2030, approximately). The fourth phase of the project involves:

- preparation of reports (safety case and environmental impact statement) for presentation to regulatory agencies (Rostekhnadzor) to obtain operating license for the DGR;
- deciding to build first stage of the DGR;
- operating the URL;
- building first stage of the DGR;
- planning first phase of works for receipt of RW for disposal;
- planning shipment of first party of RW for disposal.

Phase 5: Operation of the First Stage of the DGR and URL. Duration: 30 years or more (from 2035 to 2065, approximately). The fifth phase of the project involves:

- continuing individual experiments in the URL;
- radiological, hydrogeological, climatic, etc., monitoring;
- operating the first stage of the DGR;
- loading RW into disposal units of DGR's first stage;
- developing solutions for closing first stage of DGR.

Phase 6: Closure of DGR First Stage. Duration: five years or more. The sixth phase of the project involves:

- designing a project for closing the facility (first stage) and licensing the closure;
- executing final operations for mothballing facilities and closing first stage of the DGR;
- closing first stage of the DGR;
- implementing comprehensive monitoring program.

In addition to the steps outlined above, each phase involves public relations events, which are quite important given that public reaction to construction of the DGR remains ambivalent.

The document entitled "Strategy for Constructing a Deep Geological Nuclear Waste Repository" outlines only the main aspect of this work, which will be pursued as the DGR is constructed.

The first stage of building the DGR will involve constructing the underground research laboratory. (Figure 4 contains a diagram of the URL; the plan for constructing it is found in the chart below.)

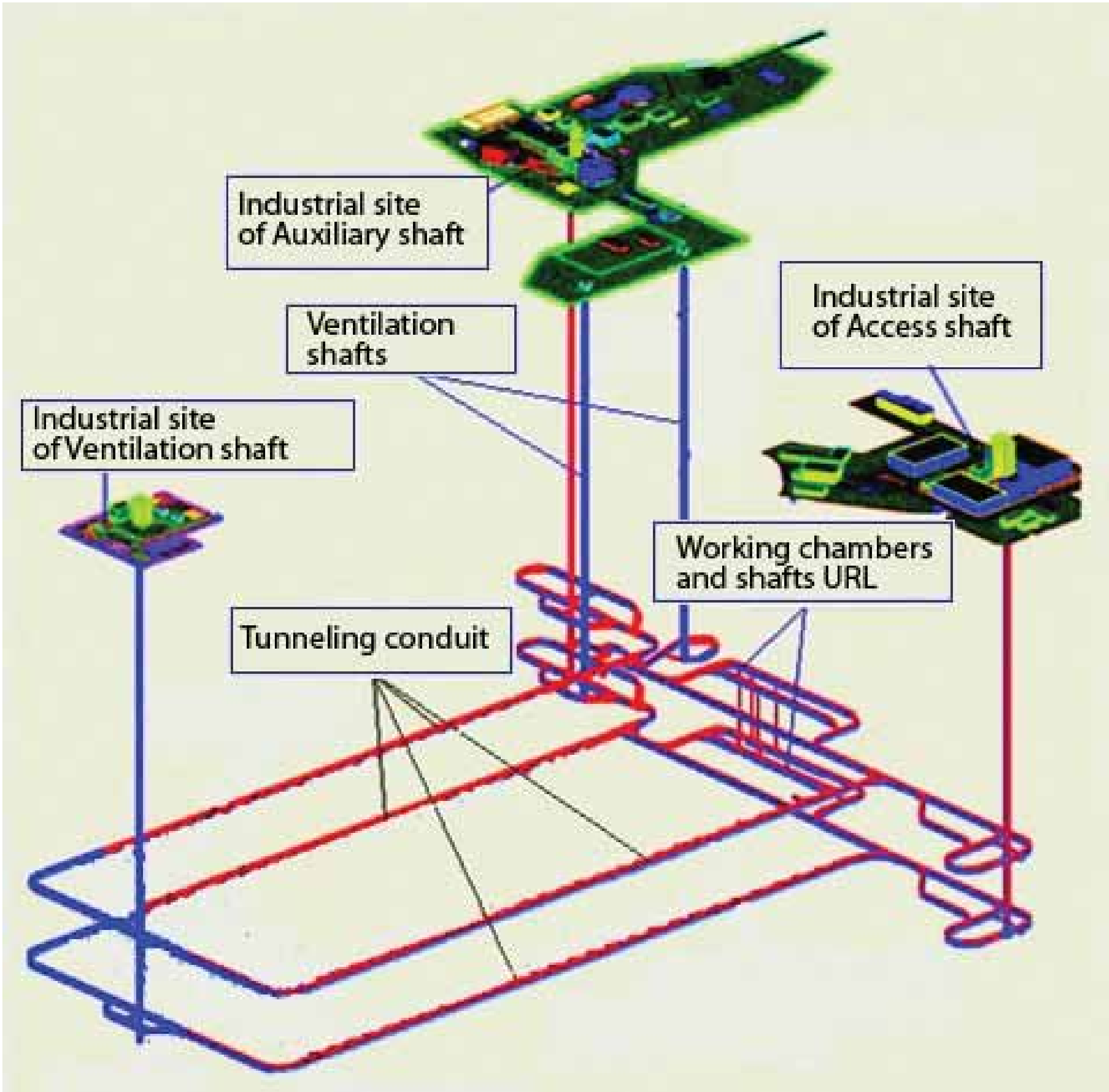

Figure 4. **Schematic diagram and main facilities of the underground research laboratory**

The URL will contain:

- two chambers (one at each level);
- a set of vertical and horizontal boreholes and shafts for implementing research;
- vertical shafts, 1.3 meters in diameter (simulated disposal canister shafts), drilled between the levels at +5 meters and –70 meters. The number of shafts between levels, simulating the shafts in a Class I RW landfill, is assumed to be four, but can be increased to eight if necessary.

In terms of construction and design, the chamber conduits are completely analogous to the working conduits for the planned RW final isolation facilities at both levels, except the straight segments.

URL Construction Plan

No.	Type of work	Period							
		2018	2019	2020	2021	2022	2023	2024	2025-2030
Construction									
1	Preparatory work, construction of line facilities, aboveground complex of buildings and facilities								
Construction of underground vertical structures									
1	Auxiliary shaft								
2	Access shaft								
3	Ventilation shaft								
4	Ventilation shafts								
Construction of horizontal conduits									
1	Transport and tunneling conduit								
2	Transport and access conduits								
3	URL conduits								
Bringing URL online									
	Operational research and licensing								
Design									
	Positive conclusion of state environmental expertise on project documentation for URL construction								
	Drafting of working documentation								

URL Research Stages and Timeframes

Stage One – 2018-2024 (7 years):

- Investigation of rock mass to depth of 700 meters during construction of three vertical shafts, 6 meters to 6.5 meters in diameter and up to 510 meters deep.

- Investigation of rock mass in an area of .4 square kilometers and between 450 meters and 520 meters deep; implementation of engineering and geological surveys, and field and laboratory studies in horizontal conduits (total length of 5,000 meters) and the exploratory shafts drilled into them.

Stage Two – from 2025:

- Improvement of techniques for handling RW on simulators in the URL's underground facilities.

- Research of insulating properties and techniques for building barriers in four horizontal conduits (total length of 600 meters) and four vertical shafts 75 meters deep.

- Continued study of rock mass in horizontal transport and ventilation conduits (total length of 5,000 meters).

The decision as to whether to continue building and operating the DGR will mainly be taken during the fourth phase of construction.

The studies performed in the URL prior to 2030 will determine whether the site chosen for the DGR meets all the safety requirements. Currently, the following conclusions and recommendations are likely. (The most likely are listed first.)

Option 1 (default). Designs, simulator outcomes, and long-term safety assessment are approved. State environmental expertise gives positive assessment and awards facility operating license.

Decision: transition to full-scale work on disposing projected amounts of RW and classifying them.

Option 2. It is concluded that operational and/or long-term safety, as supplied by the approved designs for mechanical barriers, is insufficient.

Decision: modification of the system of barriers in terms of composition, geometry and/or technology.

Option 3. It is concluded that the facility's long-term safety, as provided by the principal safeguard, the facility's geological environment, is insufficient. That is, the conclusion is reached that however many reasonable modifications are made to the system of mechanical barriers, it is impossible to safely dispose of the planned amounts and types of HRW.

Decision: depending on specific outcomes, the following options may be pursued.

Option 3a. Reducing the amounts and/or types of HRW stored in the facility. If space is available in the facility, it can be filled with types of RW to be determined after the insulation properties of the geological environment are clarified.

Option 3b. Due to safety and/or economic considerations, it is decided not to store any type of RW in the facility. The facility is used as a testing area for geological research, as well as for producing mechanical barrier systems for disposing of RW at other sites.

The choice of alternative uses for the facility will be determined by considering socio-economic factors.

V. Strategic URL Research Plan

The point of a strategic master plan (SMP) for the URL is to come up with a vision of how the DGR will operate during the main stages of its lifetime, as well as developing a long-term safety plan for the facility. The SMP will be implemented between 2017 and 2070.

As the SMP is implemented, a number of problems and tasks will have to be resolved and performed, including defining the resources and mechanisms for achieving the plan's objectives, drafting operational planning documents, shaping a consensus on how to achieve the project's objective and the means of doing it and, finally, how to shape a clear vision of what the facility should become in the future.

Construction of the DGR is implemented in stages. The first stage is construction of the URL.

Accordingly, the SMP also has its own stages, which are keyed to the stages of constructing the URL. This facilitates identifying and minimizing fundamental risks by conducting research and making adjustments. The SMP provides for safety evaluations and scientific recommendations on building and operating the URL and handling HRW.

The research program conducted in the URL includes the following trajectories:

- A geodynamic study involving surveying and geodetics. The study's main objectives are to establish the magnitudes of horizontal and vertical strains on the underground facility itself, the adjacent rock mass, and the surface facilities within the construction area during the facility's entire lifetime.

- Geomechanical studies, using geophysical methods, of the rock mass's interactions with various physical fields.

- Geophysical studies to obtain additional baseline data on the condition of the rock mass. They are needed to assess and predict the safety of the HRW buried in it.

- Hydrogeological studies to obtain baseline date for determining the actual vulnerability of the rock mass to groundwater and identifying areas of heightened fissility.

- Hydrogeochemical and radiometric students to identify fault zones and the activeness of suspected tectonic disturbances, and to assess the genesis, circulation depth, and movement of chemical and radionuclide compounds in the groundwater, including the duration of the hydrologic cycle.

- Special studies for experimentally verifying and ascertaining the correctness of design decisions concerning the site's safety.

The main objectives of the special studies are:

– A mathematical assessment of the capacity of the mechanical barriers in the inner zone to maintain their insulating properties under long-term exposure to groundwater and heat-generating RW.

– Experimental verification that the predicted temperature model matches the actual thermal field.

– Field testing of the thermophysical parameters on which the design of the facility's underground structures is based.

The special studies will also include the following:

- Verifying models for assessing the safety barriers in terms of the facility's long-term security.

- Developing techniques for boring large-diameter shafts to accommodate (simulated) HRW canisters (simulators).

- Developing techniques for delivering and isolating simulated HRW canisters in large-diameter vertical shafts, and delivering and stacking simulated HRW containers.

- Developing techniques for delivering and stacking concrete mixes for barriers.

- Refining the makeup of concrete mixes for barriers.

- Testing and improving non-standard equipment and tools under development.

- On-the-job training of personnel in handling RW at the site.

- Demonstrating to specialists and members of the public the level of safety during operations for handling RW and the feasibility of constructing the facility.

Despite the large amount of research performed and planned, specialists have noted that the area chosen is geologically complex, and so it will hardly be possible to build the facility without adjusting the design, as stipulated in the master plan.

There is no doubt the DGR will evolve over its lifetime. The DGR's lifetime should, ideally, include two stages: a short stage, lasting several decades and involving construction and use of the facility; and a long stage, lasting hundreds of thousands and even millions of years, in which the partly manmade, partly natural system would evolve without human intervention after its closure. Different trajectories of the DGR's evolution would depend on different processes that could emerge as the consequence of global and regional climatic, tectonic, cosmic, etc., events. Such events are usually random. Therefore, doing a safety feasibility study and providing scientific recommendations for building the DGR and URL, and predicting the duration of their operational and post-operation periods is a thorny task. Besides, there is virtually no timeframe for solving it, since the conditions of the task will change with time. How the mechanical barriers will behave after a hundred years, a thousand years, and longer, as they are subjected to pressure, elevated temperatures, radiation, etc., are questions that will also need to be resolved during the course of the research.

VI. Arguments Made by Opponents of the URL (DGR) in the Nizhnekansk Massif

Despite the fact that the decision to build the URL, as the first step towards building the DGR, has been made, discussions and arguments over whether the right site and method for disposing HRW have been chosen have not subsided on the web and at various special events.

Two methods of disposing HRW are used around the world: near surface disposal and deep disposal. As we noted, above, FL 190 stipulates that solid long-lived HRW must be disposed in deep disposal sites that include a facility located deeper than 100 meters below the surface. This disposal method is considered the safest.

There is another viewpoint, however. The arguments made by opponents boil down to the following points:

- Disposing HRW in deep rock formations is expensive, irrational, and less safe than in near surface disposal facilities due to the absence of reliable, objective monitoring.
- Later generations will be able to develop more advanced technology: what we now consider waste, they will regard as a valuable raw material.

Based on these considerations, opponents of deep disposal have proposed long-term storage, lasting approximately a hundred years, of RW and SNF. By eliminating a number of expensive projects, this would facilitate the refitting of current RW storage facilities and accelerate the decontamination and reclamation of polluted buildings and areas. (See http://bezrao.ru/n/201.)

In other words, there is no need to build expensive deep disposal sites. We should store RW on the earth's surface and focus on developing new technology for reducing the waste's radioactivity.

The biggest controversy has erupted over the site chosen for the URL and DGR.

A number of specialists have argued that Rosatom and the organizations involved in the project chose the site in the Nizhnekansk Massif solely because it was close the MCC, meaning that they put economic considerations above safety concerns.

Although, given that 80% of the HRW that would be buried at the Nizhnekansk DGR, if it is built, is currently stored at the Mayak Nuclear Plant and other sites, the cost of shipping it from Mayak to Krasnoyarsk would be approximately the same as, say, shipping it to the Kola Peninsula, where opponents have suggested building a DGR.

There has also been much criticism of the completeness of the research performed in the Nizhnekansk Massif. In particular, it has been claimed that the site's hydrogeology and hydrology have not been sufficiently researched. They are crucial factors in the DGR's safety, since radionuclides can enter the biosphere only through groundwater.

Experts claiming to represent the public have criticized a paper by the Khlopin Radium Institute, “Outcomes of Surveying and Scientific Research in Selecting Sites for the Underground Isolation of HRW and SNP in the Nizhnekansk Granitoid Massif,” and the ISTC’s final report on the project, “Designing a Generalized Plan of Scientific Research Towards Building a RW Underground Isolation Facility in the Nizhnekansk Massif,” calling them unprofessional and lacking in objectivity. Nevertheless, the experts admit there is no other thorough and professional research on the subject.

Opponents of the Yenisei site mainly base their arguments on the fact that the ancient Archean gneisses, highly fissile, metamorphosed, and riven by numerous dikes of average composition, have a greater filtration coefficient compared with younger granitoids. According to opponents, the site for building the DGR should be sought elsewhere, in areas with younger granitoids.

Conclusion

The project to construct the URL and DGR has only begun. There is a lot of long-term work ahead for the research, construction, operational, and other organizations involved in the project.

The preliminary research of the Yenisei site suggests it is too early to give a final evaluation of its safety and reliability as a whole. The main issue—whether the site chosen is suitable for construction of the DGR—is therefore still on the agenda.

During discussion of the strategy and program for building the DGR, experts noted the improved consistency of the list of studies proposed in the SMP. They proposed dividing the work into logical stages. If, say, it transpired the chosen site was not suitable, the question would arise as to whether there was any point in doing further scientific research at the site, as well as the economic rationale for continuing the project in light of the emergent limitations.

During its lifetime, the DGR will evolve. Its multi-barrier design and the technical solutions currently proposed will require subsequent scientific study. Certain design decisions will need to be adjusted. As currently conceived, the SMP will also evolve in step with the facility throughout its lifetime.

Additional research outcomes and adjustments must be open to discussion by the scientific community and the general public.

Experts and the public have focused on the fact that a facility is being built that is like no other in the world, a facility that is a potential source of great danger and great public interest. Failure, therefore, would damage the reputations of the people building it, as well as causing radioactive contamination of the environment and people.

Currently, members of the public and independent researchers have raised a number of questions, and the answers they have been given do not satisfy them. For example, what is the URL's real purpose? Why are enormous amounts of money being spent on it? The name of the site for which a license has been obtained (for the placement and construction of a non-nuclear radioactive waste storage facility, built, in accordance with the design documentation, for the purpose of constructing final RW isolation facilities as part of an underground research laboratory in the Nizhnekansk Massif, Krasnoyarsk Territory) suggests that a RW storage facility is being built. Of course, nuclear scientists have their own answers to these questions and their own assessments of the facility's safety, but independent researchers do not concur with the official answers and assessments.

These and other issues require the involvement of stakeholders in the early stages of drafting a safety case for the DGR and construction of the site. This would increase confidence in the project and the reliability of official safety evaluations.

Sources

A.A. Abramov, “Results of the Federal Target Program ‘Nuclear and Radiation Safety, 2008–2015.’” Presented at April 12, 2013, meeting of the Rosatom Public Advisory Council.

Aleksandr Dorofeev and Leonid Bolshov. “Stragicheskii master-plan issledovanii v obosnovanie bezopasnosti sooruzheniia, ekspluatatsii i zakrytiia punkta glubinnogo zakhoronenia radioaktivnykh otkhodov.” Radioaktivnye otkhody 1 (2017): 33 – 42, http://www.ibrae.ac.ru/docs/1.2017%20%D1%80%D0%B0%D0%BE/rwiissue1iweb_with_cover-7i34-43.pdf.

E.G. Kudriatsev et al. “Sozdanie ob’ekta okonchatel’noi izoliatsii VAO v glubokikh geologicheskikh formatsiiakh (Nizhnekanskii massiv, Krasnoiarskii krai).” Paper presented at seminar “Final Radioactive Waste and Spent Nuclear Fuel Disposal: Know-How and Plans,” Bommersvick, Sweden, February 22–24, 2009. http://docplayer.ru/54981607-Sozdanie-obekta-okonchatelnoy-izolyacii-vao-v-glubokih-geologicheskih-formaciyah-nizhnekanskiy-massiv-krasnoyarskiy-kray.html.

Minutes of the October 27, 2017, meeting of Rosatom Scientific and Technical Council No. 5 and Scientific and Technical Council No. 10.

Radioaktivnye otkhody 1 (2017). http://www.ibrae.ac.ru/pubtext/260.

Radioaktivnye otkhody 2 (2018). http://www.ibrae.ac.ru/pubtext/270.

Rosatom. “Strategiia sozdaniia punkta glubinnogo zakhoroneniia radioaktivnykh otkhodov.” Radioaktivnye otkhody 2 (3) (2018): 114–120. http://www.ibrae.ac.ru/docs/Radwaste_Journal_2(3)18/114_120_Strategy.pdf.

Trudy Radievogo instituta im. V.G. Khlopina, vol. 11 (2006). http://www.khlopin.ru/?page_id=194.

S.S. Utkin. “Kontseptsiia issledovanii v obosnovanie bezopasnosti PGZRO.” Paper presented at AtomEko-2017, November 21–22, Moscow. http://www.atomeco.org/mediafiles/u/files/2017/materials/02_Utkin_IBRAE.pdf.

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