

PRELIMINARY DESIGN OF EXPANDABLE REGIONAL STORAGE FACILITIES TO ADDRESS RUSSIAN RADIOACTIVE WASTE STORAGE PROBLEMS

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Abstract

Historical priorities in Russia did not include development of infrastructure necessary to manage radioactive waste resulting from dismantlement programs; thus, the production of waste has greatly exceeded the capacity to manage this waste creating an immediate need to design storage facilities to accept the large volumes of waste being generated. Norwegian authorities consider radioactive pollution in Russia to be one of the greatest environmental challenges the country is facing today. Norway participates in multiple international initiatives established to address the nuclear concerns in the Russian northwest, and Norway has established a direct relationship with Russia to address specific concerns. An 'Agreement on Environmental Cooperation' between the government of Norway and the Russian Federation has been implemented and includes the conceptual design for the Solid Radioactive Waste (SRW) facility.

The intent of the SRW facility project is to design a modular facility that may be expanded or duplicated as needed for interim storage of radioactive waste. The proposed facility must be designed to accommodate a variety of waste forms, radiological activities, and sizes. Considerable waste specific information has been compiled, however, it is recognized that future wastes requiring storage could differ from that currently being generated or planned for storage. The facility must therefore be flexible enough to accommodate a variety of uncertainties while maintaining a cost effective design.

The conceptual design for the SRW facility provides three options for consideration at two sites. Two of the design options include use of a lightweight structure integrated with a permanent concrete building. Lightweight structures are used in the United States as a cost-effective method of storing similar types of waste. The third option includes a traditional Russian facility constructed entirely of concrete. A fourth option is unique to one of the sites and includes utilization of an existing tunnel facility along with a new storage facility.

Introduction

In the northwest region of Russia, the projected generation of solid radioactive waste greatly exceeds the planned storage capabilities. In some instances existing solid radioactive waste is

currently stored outdoors in undesirable conditions. The wastes are of various origins and types primarily generated during the scrapping of nuclear submarines decommissioned from service in the Russian Northern Fleet but also include other regional radioactive wastes. Until the repository on Nova Zemlaya is available, these wastes need to be managed regionally in a manner that is protective of human health and the environment.

A conceptual design for the Solid Radioactive Waste (SRW) Facility has been completed and provides a detailed description of the waste quantities and characteristics of the projected waste streams in the northwest region of Russia. The facility must be designed in accordance with all applicable Russian Federation regulations and must meet the intent of internationally accepted best engineering practices for the storage of radioactive waste.

A site selection process has been initiated in northwest Russia to determine the most appropriate location for the proposed facility. The candidate sites for the storage facility originally included Andreeva Bay, RTP Atomflot, Nerpa, and Navy Yard No. 10. During the course of the conceptual design, Russian Federation authorities, through discussions with local and regional authorities, determined that Andreeva Bay and RTP Atomflot should be removed from consideration. The candidate sites now include Nerpa or Navy Yard No. 10. The final site will be selected in the beginning of the design phase of the facility.

Requirements Development

The fundamental design and engineering capabilities of Russian design firms are consistent with international engineering practices. The Russian design agency VNIPIET was selected for the conceptual design based on their experience in previous designs for radioactive waste processing and storage facilities. VNIPIET fully understands the Russian Federation regulatory requirements as well as the review and approval process ultimately necessary to proceed with construction.

Code Analysis

In order to validate that the conceptual design meets the intent of western standards, a review of Russian Federation, United States, and International codes and standards was performed. Selected codes and standards specifically applicable to design, construction, and radiation safety, were reviewed to verify that the design parameters are not significantly different from internationally accepted design practices. The principal Russian requirements in the design of a radioactive waste storage facility include safety of the individual and the environment, which is consistent with the International approach for management of radioactive waste.

Analysis of over 50 Russian codes and regulations indicates that in spite of requirements being improved over the years, a major portion of the actual standards required for radioactive waste storage were established 10-20 years ago in SPORO 85, OSP-72/78, and other regulations.

Safety requirements are identified in NRB-96 and include allowable dose limits for individuals, prohibitions of specific radiological activities, and requirements for ALARA (as low as reasonably achievable).

Waste Characteristics

There are a large number of enterprises and buildings located and operated in the northwest region of Russia. The primary waste generating facilities include Navy bases and Ministry of Economics yards supporting the dismantlement of nuclear submarines. Waste generated at these facilities includes liquid and solid radioactive waste. The waste data obtained during site visits and review of record data is consistent with the physical and radiological data that had been previously understood, however, the projected volumes of waste to be generated appeared significantly high. With the design concept for an expandable facility, the volume of waste is not a critical data point. If the volumes are actually lower than projected, then the second module of the building is either postponed or cancelled and no cost is expended.

The radioactive waste categories are based on radiological activity and are defined as Activity Group I, II, or III where:

- Activity Group I: 10 –30mRem/hr at 10 cm
- Activity Group II: 30 mRem/hr – 1 Rem/hr at 10 cm
- Activity Group III: greater than 1 Rem/hr at 10 cm

The primary nuclides in the waste are Cs¹³⁷, Sr⁹⁰ and Co⁶⁰.

Liquid waste generated consists of primary loop coolant, biological shielding water, and decontamination waters. All of the liquid waste must be solidified prior to acceptance in the storage facility.

Solid waste generated includes combustible items, resins, and metal. Combustible items are clothing, rags, boards, and other ancillary items used in the dismantlement efforts. These items are segregated because of the additional fire protection requirements. Resins consist of inorganic sorbents used in processing, and the metal waste includes a large variety of items from pumps to reactor components. Based on current programs underway in the region, it is estimated that approximately 75% of the metal waste could be decontaminated, if a facility existed for this purpose. The remaining 25% can not be decontaminated either because of the intricacy of the component or because of induced activity.

Based on the waste characteristic data compiled, a storage building should be designed for low, medium, and high level waste with a total volume of 10,000 m³. The first module should include

3,500 m³ of combustible waste and high level waste and 6,500 m³ of low and medium level waste. Spent fuel will not be stored in the facility and is not included in this program.

Waste Acceptance Criteria

Waste acceptance criteria (WAC) are established to assure that the waste received into the building is within the design envelope. The building will be designed for a specific waste inventory and verification methods must be in place to ensure that this inventory is not exceeded. The design envelope includes Activity Groups I, II, and III radioactive waste. The WAC established for the building will include requirements for generator waste certification, characterization, traceability, waste form, packaging, and transfer. To the extent practical, the waste will be characterized to meet anticipated disposal requirements. However, the intent of the storage facility is to provide immediate and safe storage for waste currently generated. Therefore, the WAC is not intended to restrict waste that would otherwise meet the storage requirements.

Operational WAC requirements developed in the final design must include requirements for full characterization to ensure that non-compliant waste is not received for storage. The operational waste acceptance criteria should establish requirements for types of waste, free liquids, chemical constituents, off gassing, packaging, and numerous other waste specific requirements. The level of effort necessary to characterize waste will be dependent on the confidence of the original data received.

Related Projects

The conceptual design for the SRW facility was developed in consideration of related projects under development or necessary for life cycle management of waste in northwest Russia. RTP Atomflot facilities for waste processing will be in place and operating prior to the construction of the SRW facility. Waste from this site will be ready for transport to the SRW facility and is expected to be the first waste stream to enter the building. The following related projects are currently under development in the region:

- Concrete containers are currently being developed for solidified waste at RTP Atomflot. However, these containers are not efficient for solid waste items. It is desirable to develop more efficient Russian containers, however, western containers can also be licensed for waste storage in Russia.
- A container project also exists within the AMEC program to procure round metal storage containers for radioactive waste.
- Handling facilities and procedures are needed at each site where waste is presently stored or being generated to ensure that the initial waste characterization is acceptable

for transportation and storage and to allow repackaging into approved containers. The AMEC program for mobile liquid waste treatment would satisfy the processing requirements for the liquid waste.

- Transportation requirements include the need for a ship and a vehicle to transport waste from the sites of generation to the storage building. Existing ships are available and currently in use, however, the reliability of these existing transports is uncertain.
- Processing facilities are ultimately needed to volume reduce the waste to maximize storage capacity. The AMEC program for mobile solid waste treatment would satisfy the volume reduction requirements for solid waste.

Licensing of Facilities

The Russian procedure for licensing of a new facility is complex. Local and central Authorities are responsible for site selection. The primary approvals, which will be given by local and central Authorities, are:

- Site approval for location of the storage building (Administration of Murmansk)
- Approval to start construction work will be given after a feasibility study is approved (Ministry of Economics and Ministry of Defense)
- Approval to start operation will be given after successful commissioning. Local and central Authorities will not give the permission to start operation until all Gosatomnadsor and Ministry of Health comments have been resolved.

Gosatomnadsor has the overall responsibility of ensuring that regulations and standards are implemented to reduce the risks for radiological accidents. For this purpose, Gosatomnadsor issues licenses to the enterprises involved in the design and construction of the facility. During the design and construction work, Gosatomnadsor inspects ongoing work and provides comments. Gosatomnadsor will also issue licenses to the operators of the facility after having controlled their training.

The Ministry of Health and their local representation offices are responsible for securing the health of the operators and the population in general. Under this perspective, the Ministry of Health provides comments on the design and during the commissioning.

The State Environmental Commission investigates the effect a new facility may have on the environment. The Commission provides ecological expertise on the part of the design that is subject to approval. In addition to the design documentation, the Commission will consider

comments from Gosatomnadsor and the Ministry of Health as well as results of the public discussions.

Conceptual Design

Storage concepts were developed with consideration to stipulated Russian Federation regulatory and licensing requirements. Compliance with these requirements assures that the facility will be designed and constructed in a manner that is protective of human health and the environment. A brief listing of the general design requirements includes:

- Prevention of radionuclide discharge to the environment during routine operation
- Separation of different types of radioactive waste
- Consideration of potential discharges during design accidents
- Consideration of internal transportation means
- Radiation monitoring and control systems
- Engineered ventilation system, special sewage collection system, fire protection, physical protection, and special systems.

Operational requirements are also considered to ensure that the physical and administrative systems perform effectively.

Four options have been considered for the SRW facility:

1. A concrete primary structure with two small lightweight structural additions for the storage of Activity Group I and II waste
2. A concrete primary structure with one large lightweight structural addition for the storage of Activity Group I and II waste
3. A traditional concrete structure for storage of all waste
4. Use of an existing tunnel structure for Activity Group III waste and combustible waste and a small concrete primary structure with one lightweight structural addition for the storage of Activity Group I and II waste. This option is only available at the Navy Yard No. 10.

For Option 1, each subsequent phase would include the addition of two lightweight structural additions. Option 2 and 4 would require the addition of a single lightweight structural addition with each subsequent phase.

The primary structure for options 1, 2, and 3 is a concrete building that includes the waste receiving area, transportation corridors, and a storage area for the Activity Group III waste and the combustible waste. The concrete structure for option 3 provides storage for all activities of waste. The concrete structure in option 4 provides the support functions to receive and transport the waste into the lightweight structure. For all options, the Activity Group III waste is segregated

because of the increased shielding requirements, and the combustible waste is segregated because of the increased fire protection requirements.

The interior transportation system is designed to allow receipt of the waste in a controlled environment. Incoming waste is monitored for radiation and is identified through a waste tracking system to establish a storage address. Internal movement and storage of the waste will be provided with the use of a forklift and overhead crane. The waste receiving area provides for movement of Category III waste by crane and provides forklift access for all other waste types. Category III waste is remotely moved by crane into concrete storage cells that provide required shielding.

General storage areas will be designed to receive cages of waste drums and may be stacked four levels high. Each cage is typically designed to hold four standard 200 liter drums. However, a variety of containers and waste sizes may be stored in the facility.

A radiation monitoring system will be designed for monitoring of radiological parameters for operational safety, transportation, and storage of the waste. Fixed wall monitors will be located throughout the building, ventilation monitors are provided for exhaust, and portable monitors are provided for routine contamination surveys, personnel and vehicle monitoring.

Evaluation of Environmental Impact

The evaluation of environmental impact is the process of confirming that the storage facility, with consideration of the waste contents, will perform in a manner that is protective of human health and the environment. The objective of the planned activity, which is storing of radioactive waste, is classified as the source of environmental effect, and is therefore subject to meeting the regulations and requirements for radiation safety. In accordance with regulatory requirements, the environmental effect must be within the limits of acceptable risk.

With the operational controls and design features, the assumption of this conceptual design is that the consequences of design and beyond design basis accidents will not lead to significant deterioration of a radiation situation. It must be understood that a prerequisite for achieving this assumption is that the inventory meets the established waste acceptance criteria.

Conclusion

Because historical priorities in Russia did not include development of infrastructure necessary to manage radioactive waste resulting from dismantlement programs, the production of waste has greatly exceeded the capacity to manage this waste creating an immediate need to design storage facilities. The intent of the SRW facility project is to design a modular facility that may be expanded or duplicated quickly and cost effectively as needed for interim storage of radioactive

waste. A conceptual design for the SRW facility has been completed under the 'Agreement on Environmental Cooperation' between the government of Norway and the Russian Federation.

A storage facility must be designed to accommodate a variety of waste forms, radiological activities, and sizes. It is recognized that future wastes requiring storage could differ from that currently being generated or planned for storage, therefore the facility must be flexible enough to accommodate a variety of uncertainties while maintaining a cost effective design. Based on the waste characteristic data compiled, a storage building should be designed for low, medium, and high level waste with a total volume of 10,000 m³. The first module should include 3,500 m³ of combustible waste and high level waste and 6,500 m³ of low and medium level waste.

The SRW Facility is being implemented by the Norwegian Government and requires oversight to ensure that the facility meets minimum established standards. Evaluations to date have indicated that the processes and design practices in the Russian Federation are comparable to International Standards. These evaluations include a review of design standards, radiation safety standards, and environmental assessment requirements. Detailed review of these requirements should be conducted during the design phase to ensure that the facility meets Russian Federation requirements and meets the intent of International design and radiation safety standards.