STORAGE OF SOLID RADIOACTIVE WASTE FROM THE NORTHERN FLEET OF THE RUSSIAN NAVY UNDER THE AMEC PROGRAM

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ABSTRACT

The Arctic Military Environmental Cooperation (AMEC) Program is a cooperative effort between the military establishments of the Kingdom of Norway, the Russian Federation, and the United States. This paper discusses joint activities over the past year among Norwegian, Russian, and U.S. technical experts on solid radioactive waste storage technologies in the Arctic for the Russian Navy. These are Western as well as Russian developments and will facilitate meeting the Russian Navy's needs for storing solid radioactive waste from decommissioned nuclear submarines. The first batch of multiple-use steel containers for transportation and storage of solid radioactive waste have been fabricated at a Russian shipyard and work on the second batch is in process. The partners are also working on single-use concrete containers for transportation and long-term storage, lightweight modular storage buildings, and Russian-made radiation monitoring equipment for use in waste storage facilities. All work is directed at applications in northwest Russia where the Russian Navy is decommissioning large numbers of nuclear submarines and accumulating large amounts of solid radioactive waste. The mission of AMEC Project 1.4 is to improve the Russian Navy's capabilities in solid radioactive waste storage and thus minimize the spread of radiological contamination. The ultimate goal of this project is a safe, secure, and self-sustaining solid radioactive waste storage capability in northwest Russia.

INTRODUCTION

On 31 July 1991, President George Bush of the U.S. and General Secretary Mikhail Gorbachev of the Soviet Union signed the START I Treaty. This treaty was ratified by the U.S. Senate and by the

Russian Duma and it entered into force on 5 December 1994. On 3 January 1993, President George Bush of the U.S. and President Boris Yeltsin of the Russian Federation signed the START II Treaty. This treaty was similarly ratified and it entered into force on 14 April 2000. The U.S. and the Russian Federation are now actively engaged in implementing the provisions of these two treaties.

In order to satisfy the START I and II Treaty provisions and verification requirements, Russia is reducing the number of deployed strategic weapon systems across the board, including its submarine-launched ballistic missile launchers. The dismantlement of these nuclear-powered submarines represents a major source of radioactive waste in northwest Russia. Furthermore, the Russian Navy is also removing general-purpose nuclear-powered submarines from service as they reach the end of their design lives or as the Navy decides they are no longer necessary. This represents another major source of radioactive waste in northwest Russia. One of the consequences of these activities was the creation of the Arctic Military Environmental Cooperation (AMEC) Program. The overall AMEC Program is discussed elsewhere in this conference (1), while this paper focuses on AMEC Project 1.4, "Solid Radioactive Waste Storage Technologies".

The volume of solid radioactive waste at the Northern Fleet naval bases and shipyards in 1996 was estimated to be about 8,000 cubic meters (2,3). The waste generation rate was estimated to be about 1,000 cubic meters per year (2,3) at that time. Two recently published reports have estimated this volume at about 9,000 cubic meters (4) and 20,000 cubic meters (5). This waste is located at or near Andreeva Bay, Murmansk, Gremikha, and Severodvinsk, as shown in Figure 1.

Fig. 1. Northwest Russia

The waste consists of combustible materials, such as wood, paper, and fabric; compactible materials, such as plastics and rubber; metal equipment, fittings, and pipes; and non-processable materials. By any measure, this is a large volume of waste to be managed and the existing waste management infrastructure is not adequate for this task. These materials and their storage conditions have been recognized as a priority by several agencies of the Russian government (6). At the present time, there is no operational disposal site for this waste stream. Therefore, safe and secure waste storage is a high priority.

The mission of AMEC Project 1.4 is to improve the Russian Navy's capabilities in solid radioactive waste storage and thus minimize the spread of radiological contamination. The ultimate goal for this project is to develop a self-sustaining radioactive waste storage capability, which will permit the Russian Navy to store its solid radioactive waste safely and securely without participation from the U.S. or Norway. The present paper is the fourth in a continuing series of papers presented at these annual Waste Management conferences (7,8,9).

The Project is pursuing six technologies related to storage and transport of solid radioactive waste, as shown in Figure 2. These activities will fit together to develop a self-sustaining storage system.

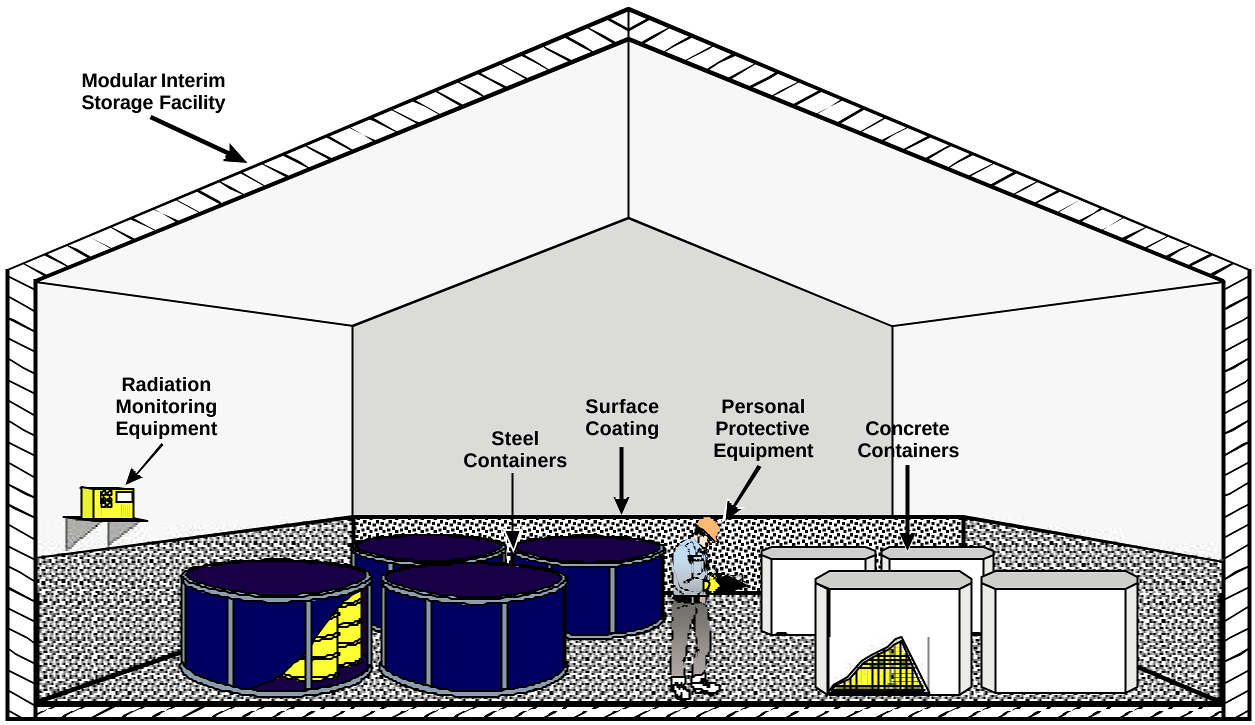

Fig. 2. AMEC Project 1.4 Activities

STORAGE BUILDINGS

The Russian side has completed a solid radioactive waste storage building. This facility will be primarily used to store old wastes that have been in the open air for years at Andreeva Bay. The storage facility has below-grade vaults with concrete lids and a 20-tonne bridge crane. The estimated Russian expenditure for this facility was roughly $7.4 million, $800,000 of which has been provided since it was first proposed as an AMEC project.

Additional storage buildings could be constructed in the next few years. The Project Officers are evaluating lightweight steel construction for these additional buildings. The design criteria for these buildings include heavy snow loads (200 kg/m^2), high wind loads (100 kg/m^2), and low temperatures (-60^{o}C). The first such building is planned to be built in Murmansk and to be used as a staging facility for empty waste containers. The second and third such buildings will be built at Navy Yard No. 10 near the City of Polyarny on the western side of the Murmansk Fjord. They will be used to house the Mobile Pretreatment Facility in AMEC Project 1.3 (10) and to store filled containers.

COATING TECHNOLOGY DEMONSTRATION

The coating material selected was Polibrid 705, a thermosetting elastomeric polyurethane supplied by Promatec Technologies, Inc. The U.S. team of technicians assembled and tested the equipment, and trained the Russian technicians during the summer of 1998. The Russians then sprayed a portion of the coating material on the concrete floor of a loading bay of a radioactive waste handling building, an indoor passage in the same building, the external surfaces of a steel container, and 24 concrete and metal laboratory test coupons.

The coatings on the loading bay and indoor passage floors were exposed to the normal working environment over a period of one year and their conditions were monitored at regular intervals. The Polibrid 705 coating demonstration was completed in August 1999 and the results were documented in the final report issued in September 1999. This coating demonstration is discussed in more detail elsewhere in this conference (11).

STEEL CONTAINERS

There is an acute shortage of high-quality certified containers for transportation and interim storage of solid radioactive waste in Russia. To address this need, Project 1.4 is sponsoring the development of reusable waste containers made of steel. Using U.S. funding, the Zvezdochka Shipyard in Severodvinsk, Russia, designed a suitable container and named it the PST 1A container. The PST 1A container is shown in Figure 3 and the main technical characteristics are presented in Table 1. The PST 1A container is large enough to hold seven standard 200-liter drums and it satisfies both international (IAEA Type A) and Russian (GOST 16327-88) safety standards.

Fig. 3. PST 1A Containers at the Zvezdochka Shipyard

Table I. PST 1A Container Characteristics	
External Diameter	2000 mm
Internal Diameter	1860 mm
External Height	1274 mm
Internal Height	950 mm
Internal Volume	2.58 m^3
Empty Weight	990 kg
Transport Payload	2300 kg
Service Life	At least 10 years
Wall Thickness	6 mm
Retain contents under a reduction of ambient pressure down to	25 kPa

The certification process in Russia is complicated and sometimes presents a serious obstacle to project completion. In this particular contract, the burden of certification was placed on the supplier. The PST 1A containers were fully certified by the Russian regulatory authorities Gosstandardt and Minatom as part of the contract requirements. At this time, these containers are the only containers certified for general transport of solid radioactive waste throughout the territory of the Russian Federation. They can be transported by truck, rail, or barge. The Russian Navy formally took possession the first 100 PST 1A containers in October 2000. The construction of these containers is discussed in more detail elsewhere in this conference (12).

If this initial effort is to grow into a self-sustaining enterprise, the Zvezdochka Shipyard must make their container fabrication line commercially successful. To this end, the Shipyard has advertised the PST 1A container for sale. The Shipyard displayed a container at the Third International Exhibition and Conference on Radiation Safety and Transportation of Radioactive Materials "ATOMTRANS-2000" in St. Petersburg in November 2000.

Project 1.4 is now sponsoring the fabrication of a second, larger batch of 300 PST 1A containers. For the first batch, each of the 100 containers was certified individually. The current contract includes a requirement for a "Certificate of the Type" from the Russian regulatory authorities, which means that the design and the manufacturing facility will be certified. This will represent another major step towards a self-sustaining container manufacturing capability in Russia.

CONCRETE CONTAINERS

AMEC Project 1.4 is also sponsoring work on single-use containers made of concrete, as shown in Figure 4. The objective of this task is to provide a long-term (up to 300 years) storage and handling package. It is also important that the concrete will be durable enough to satisfy the IAEA and Russian transport requirements for 50 years.

A contract has been signed with ICC Nuclide in St. Petersburg, Russia to finish the container design, to fabricate 13 prototype containers, to test these prototype containers, and to certify the container design. The design has been finished and the durability of the concrete has been investigated. The designs of the container handling equipment have also been finished. This phase of the concrete container task is scheduled to be completed in August 2001. The Project Officers also plan to continue the work, including pilot production of sixty more containers.

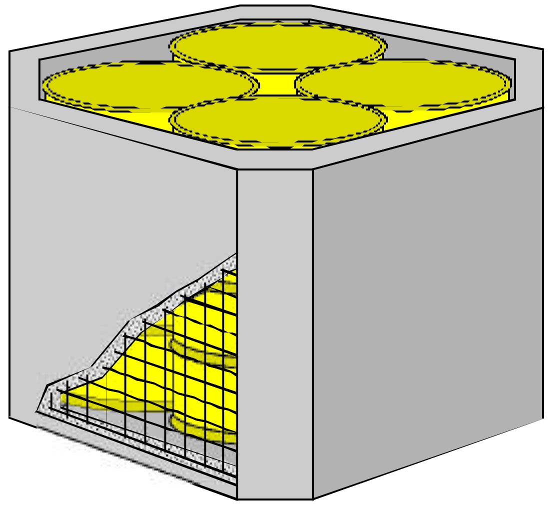

Fig. 4. Concrete Container

RADIATION MONITORING EQUIPMENT

The objective of this task is to provide and install Russian-made radiation monitoring equipment that meets or exceeds all applicable Russian regulations and is at least consistent with Western standards for similar applications. For example the new waste storage building constructed by the Russian Navy at Andreeva Bay has no radiation monitoring equipment or alarms installed. This is not consistent with Russian or Western standards. Any new waste storage buildings that might be constructed under AMEC Project 1.4 will also need radiation monitoring equipment that meets Russian regulations and Western standards.

PERSONAL PROTECTIVE EQUIPMENT

The Project Officers also plan to provide Western personal protective equipment to protect the workers from radioactive contamination. When the waste has surface contamination, handling it may lead to contaminated dust becoming airborne. Norway delivered some samples of personal protective equipment to the Russian Navy in June 1998. The Russian Navy evaluated this equipment during 1999 and stated that the two most useful items are protective/anti-contamination clothing with lining for cold weather and multiple-use full-face respirators. The project will therefore provide single-use disposable equipment for a limited test period as well as some multiple-use respiratory equipment and protective clothing in order to test the equipment's functionality relative to present equipment. A protocol defining the working conditions and procedures for application and/or decontamination will need to be developed in Russian.

CONCLUSION

The selected technologies will serve to support and enhance the Russian Navy's efforts to manage their solid radioactive waste. The creation of a self-sustaining waste storage infrastructure featuring containerized waste in safe, secure facilities will be a challenge given the current Russian economy. With the trilateral cooperation of the AMEC Program, however, this goal is within reach.

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