COMMISSIONING AND TESTING OF THE FIRST INTEGRATED SNF TRANSSHIPMENT/INTERIM STORAGE FACILITY IN NW RUSSIA

R. S. Dyer, E. Barnes
U.S. Environmental Protection Agency
Washington D.C., United States

R. L. Snipes
Oak Ridge National Laboratory
Oak Ridge, Tennessee, United States

S. Høibråten
Norwegian Defence Research Establishment
Kjeller, Norway

ABSTRACT

Northwest Russia contains large quantities of spent nuclear fuel (SNF) that potentially threaten the environmental security of the surrounding Arctic Region. The majority of the SNF from the Russian decommissioned nuclear submarines and civilian icebreaker fleet is currently stored either onboard submarines or in floating storage vessels in Northwest Russia. Some of the SNF is damaged, stored in an unstable condition, or of a type that cannot currently be reprocessed. Existing Russian transport infrastructure and reprocessing facilities cannot meet the requirements for moving and reprocessing all of this fuel, including the objectives/requirements of the Strategic Arms Reduction Treaty (START). Additional interim storage capacity is required. Most of the existing storage facilities being used in Northwest Russia do not meet health and safety and physical security requirements. The removal, handling, interim storage, and shipment of the fuel pose technical, ecological, and security challenges.

The U.S. Environmental Protection Agency (EPA), in cooperation with the U.S. Department of Defense and the Department of Energy's (DOE) Oak Ridge National Laboratory, along with the Norwegian Defence Research Establishment, is working closely with the Ministry of Defence and the Ministry of Atomic Energy of the Russian Federation (RF) to develop an integrated management system for interim storage of SNF in NW Russia. This system, with the support of the U.S. DOD Office of Cooperative Threat Reduction (CTR), is being developed under the Arctic Military Environmental Cooperation (AMEC) Program. AMEC is the result of a tri-lateral military agreement involving Norway, Russia, and the United States where the three countries are working together to solve military environmental problems. The AMEC 1.1 Project consists of three subprojects that constitute an improved and integrated SNF management system that meets RF and international requirements.

The subprojects are: (1) development of a prototype dual-purpose, metal-concrete 40-tonne container for both the transport and long-term storage of RF SNF - AMEC 1.1, (2) development of the first transshipment/interim storage facility for these containers - AMEC 1.1-1), and (3) development of improved fuel drying and cask dewatering procedures for controlling the moisture levels within the 40-tonne containers filled with spent nuclear fuel - AMEC 1.1-2.

The first subproject, development of a dual-purpose container, was completed in December 2000. This was the first metal-concrete container developed, licensed, and produced in Russia for both the transportation and storage of military SNF. These containers are now being serially produced in NW Russia. Russia is using these containers for the transport and interim storage of military SNF from decommissioned nuclear submarines at naval installations in the Arctic and Far East.

The second subproject is the design, construction, licensing, and commissioning of the first transshipment/interim storage facility in Russia. The facility has been licensed and commissioned for full operation. Facility construction was completed in September 2003 and the RF State Acceptance Commission approved the facility in January 2004. The facility is now in a full operation. This facility has been constructed at FGUP "Atomflot" in Murmansk, Russia for interim storage of up to nineteen 40-tonne containers for a period not to exceed one year. The primary objective of building the transshipment/interim storage facility is to remove a bottleneck in the RF transportation infrastructure for moving the dual-purpose containers, loaded with SNF, from the Arctic Region to PO "Mayak" for reprocessing or longer-term storage. The transshipment/interim storage facility is located adjacent to both the pier and railhead at FGUP "Atomflot". This location also has access to the site's 100-tonne Kone crane which allows for the seamless transfer of SNF from specially designed transport and storage vessels into the dual-purpose 40-tonne containers; and then movement of the containers to the storage facility for interim storage. Subsequently, the crane moves the containers from interim storage onto the special rail cars designed for transporting the containers to PO "Mayak" in the Ural Mountains.

The third subproject addresses the need to improve dry storage conditions within the containers for storage of SNF for up to 50 years. Currently, a limited amount of residual moisture is allowed to remain in the casks. With the possibility of longer-term storage at PO "Mayak" prior to reprocessing, the need arises to store the fuel under drier conditions. This involves the development of modified fuel drying and cask dewatering techniques from those currently used in the RF. An initial Feasibility Study has been completed for the project. The Study documented the current RF, and other western countries, methods for conditioning the SNF and preparing casks for transport and/or storage. The Study also presented conceptual designs for new/modified conditioning systems for use in the RF and evaluated potential sites for the development and location of a mobile demonstration system. Sites being considered include the Zvezdochka Facility in Northwest Russia and the Zvezda Facility in the Far East.

Upon completion, these subprojects are designed to provide a physically secure, accountable, and environmentally sound integrated solution that will specifically accommodate the requirements of increased removal and transfer of SNF from decommissioned RF submarines in the NW Russian Arctic to PO "Mayak" in central Russia, but are also applicable to the Russian Far East requirements.

INTRODUCTION

This group of projects is being implemented under the framework of the Arctic Military Environmental Cooperation (AMEC) Program, which focuses on environmental problems in Northwest Russia. However, the SNF management system developed under these three projects is equally applicable to the Far East. The AMEC Program, an agreement between the Defense Ministries of Norway, Russia, and the United States, was initiated in 1996 to create a forum for increased dialogue and development of joint activities addressing Arctic military environmental issues, particularly in Russia. The United Kingdom joined AMEC in 2003.

AMEC Projects 1.1, 1.1-1, and 1.1-2 address specific environmental issues associated with the removal, transportation, and storage of SNF from nuclear submarines being decommissioned in Northwest Russia under the START. AMEC Project 1.1 involves the development of a 40-tonne SNF cask suitable for both transportation and interim storage (up to 50 years) of the SNF being removed from the submarines. Construction of the prototype dual-purpose cask was completed on schedule in September 1999, and the cask was tested and certified for production in December 2000. AMEC Project 1.1-1 involves the development of a suitable facility for interim storage and transshipment of the dual-purpose casks. The storage pad construction was initiated in mid-2000 and completed in September 2003. Facility hot-testing was conducted in June and August 2003 and the Facility was fully commissioned for operation in January 2004. The third project is to improve the quality and extend the duration of fuel storage in the 40-tonne casks by developing fuel drying and cask dewatering technology (AMEC Project 1.1-2). This project was

initiated in 2002 and is scheduled for completion in 2005. The AMEC Program includes other radiation and non-radiation environmental projects.

AMEC PROJECT 1.1 – SNF TRANSPORT AND STORAGE CASK

The specific objective of this project was to design, fabricate, test, and certify a prototype 40-tonne transport and storage cast for use in Russia. The Norwegian Defence Research Establishment, the Russian Ministry of Atomic Energy, and the U.S. Environmental Protection Agency initiated AMEC Project 1.1 in February 1997.

The TUK-108/1 cask is a metal-concrete cask designed to contain up to 49 undamaged fuel assemblies. It is approximately 4.5-m high and 1.6-m in diameter and will weigh approximately 40 metric tonnes when loaded. The cask is comprised of three concentric metal shells attached to a common forging (coaming) at the upper end and metal bottom pieces for each of the shells. High-density concrete is poured between the metal shells to form two separate concentric concrete shells. The inner concrete shell is significantly thicker than the outer concrete shell and serves as the primary structural and shielding element for the cask. The outer concrete shell provides additional strength and shielding but also serves as a sacrificial shell which functions as an "impact limiter" in case of an accident.

The cask is sealed at its upper end by two separate metal lids. The inner lid serves as both a shielding and first containment barrier for the contents. The outer lid serves as the second containment barrier and provides structural protection for the inner lid. The outer lid also serves as an "impact limiter" or "damping device" during an accident. The bottom portion of the cask and the outer lid of the cask both incorporate metal-rib damping devices as an integral part of their construction. Previous generations of RF metal-concrete casks have utilized removable damping devices bolted onto the cask. Therefore, this cask requires no additional bolt-on damping devices for transportation. The cask is designed for at least a 50-year life and meets all applicable Russian and International Atomic Energy Agency (IAEA) standards for storage and transport of SNF.

The development, design, fabrication, and testing of the AMEC prototype cask has been discussed in detail at previous Waste Management Conferences. [1,2,3] The cask design has been certified for both transport and storage of RF military SNF by the RF Ministry of Defence, Minatom and the Ministry of Health. Figure 1 shows the TUK-108 Prototype Cask with one fuel canister installed and the remaining six fuel canisters for the cask. The serial production of the TUK-108/1 cask started in 2000.

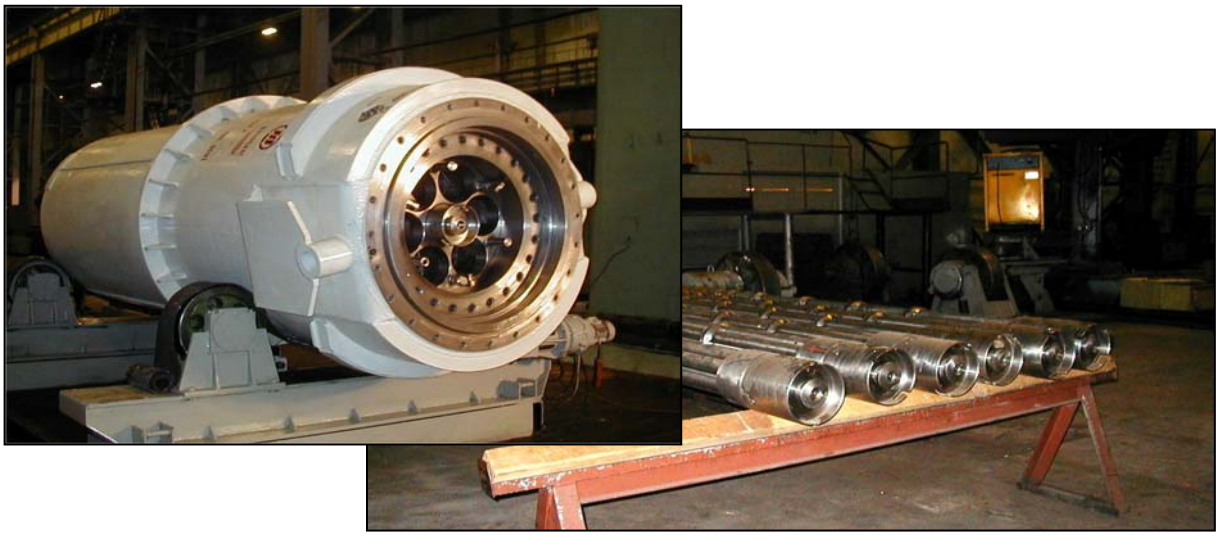

Fig. 1 TUK-108 Prototype Cask and Fuel Canisters, Izhora Works Facility, St. Petersburg, Russia.

AMEC PROJECT 1.1-1 – SNF TRANSSHIPMENT/INTERIM STORAGE FACILITY

The objective of this project is to design, construct, and license a facility suitable for interim storage of up to nineteen of the TUK-108/1 40-tonne casks containing SNF. The transshipment/interim storage facility design includes a reinforced concrete foundation for storing the 40-tonne casks in a vertical position. Vertical concrete shield walls are constructed around the outer periphery of the foundation plate to minimize radiation dose to site workers required to pass the storage facility. These shield walls extend upward to about two-thirds of the cask's height.

The storage facility at FGUP "Atomflot" meets all Russian codes and IAEA standards and guidelines for the design, construction, and licensing of a transshipment storage pad for SNF. The storage facilty is designed for at least a 50-year service life. Current plans are for loaded casks to be temporarily stored in the pad for 30-60 days, but no longer than 1 year. The storage facility is also designed to withstand the extreme temperatures (-50^{o}C to +32^{o}C) of the Arctic, and maximum seismic activity of 6 points on the MSK/Richter scale. The facility is located and designed to facilitate the use of existing equipment, railways, and transfer and handling facilities. The storage facility is designed to accommodate both TK-18 transport casks and the new TUK-108/1 transport and storage casks while utilizing the existing cask fuel loading facilities (floating service ships) and rail transport cars. The project also supported the RF in designing and installing appropriate physical protection, and material accounting and control systems for the SNF being stored at the facility.

Preliminary storage facility construction activities began on site in September 2000. The major components of the Storage Facility include: the concrete foundation plate and walls; metal roof and cask coverings; dress out area; environmental/radiation monitoring system; physical protection system; and fuel accounting and control system. Project 1.1-1 provides for all facility environmental/radiation monitoring required by RF standards and norms for operation of the SNF storage facility. Another AMEC Project (1.5-1) has installed a system, the PICASSO system, that provides additional environmental/radiation monitoring for a larger area of the FGUP "Atomflot" Facility. The PICASSO system provides additional environmental/radiation monitoring for the storage facility and integrates the readings from the AMEC 1.1-1 facility with those from other facilities within the FGUP "Atomflot" Complex. Figure 2 shows the TUK-108 prototype cask in the Facility during the initial cold-testing of the Facility in June 2003.

Fig. 2 TUK-108 Prototype Cask in one of the 19 storage cells during cold-testing of the Transshipment/Interim Storage Facility, June 2003.

Facility hot-testing was conducted in June and August 2003. Figure 3 shows the completed storage facility undergoing a series of hot-tests in August 2003. Three RF TK-18 SNF casks loaded with actual RF submarine fuel were used in the series of hot-tests. The photograph shows the full facility including: the shielding walls; metal roof, boxes and lids of the 19 cask storage/transshipment cells; and the rails for the Kone crane in the foreground. The worker dress-out area and sanitary walkway are located in the building immediately behind the storage facility.

Fig. 3 Hot-testing of the AMEC 1.1-1 Transshipment/Interim Storage Facility at the FGUP "Atomflot" Facility, Murmansk, Russia, August 8, 2003.

The following Russian permits/licenses were obtained for the construction and operation of this storage facility:

- The RF operator of the site, FGUP "Atomflot", obtained a permit/license from Gosatomnadzor (GAN) for siting and constructing the interim/transshipment storage facility.
- The RF organizations constructing the storage facility possessed the appropriate permit/license from Minatom to construct such nuclear facilities.
- The facility operator obtained a permit/license from Minatom for operating the facility.

The only remaining regulatory issue is the division of responsibility between the RF GAN and UGN YaRB, the RD MOD regulatory body, for overseeing the facility operation.

The official RF Working Commission, consisting of representatives of the Facility designers, constructors, and operators, completed its review of all facility construction and operating procedures in August 2003. All construction activities, including corrections directed by the RF Working Commission, were completed in September 2003. Figure 4 shows the lowering of the TUK-108 prototype cask into the

completed Facility during the November 2003 Project Promotional/Completion Event attended by many high ranking civilian and military officials from Norway, Russia and the United States. Following the completion of the RF Working Commission's activities, the official RF State Acceptance Commission met and accepted the facility in January 2004. Acceptance by the RF State Acceptance Commission means that the facility has been fully commissioned and is ready to be prepared for full-scale operation.

Fig. 4 TUK-108 Prototype Cask being placed in the Storage Facility during the November 2003 Project "Promotional Event" noting the completion of the Facility construction.

AMEC PROJECT 1.1-2 – SNF CASK DEWATERING AND FUEL DRYING SYSTEM

To increase the operational safety and performance of the 40-tonne casks, a new project was initiated to review and improve existing fuel drying and cask dewatering systems and procedures. Current SNF management procedures allow up to 3.2 liters of residual moisture to remain within the cask after it is sealed. This residual moisture significantly increases the chances for corrosion and hydrolytic gas production within the cask if stored for long periods of time (up to 50 years). This project will provide a detailed review of existing fuel management methods, including both physical systems and procedures. This review will also identify any required modifications to ensure that the cask can be safely and effectively used over its lifetime to transport and store SNF without any problems of corrosion and gas production. A Conceptual Plan for the project was completed and approved in August 2002. The Project's Technical and Economic Feasibility Study has also been completed and the new system design is being developed for the drying of the fuel and packaging it in the TUK-108/1 cask.

CONCLUSIONS

Under trilateral Norwegian, Russian and United States sponsorship, a dual-purpose 40-tonne metal-concrete spent nuclear fuel transport and storage cask has been designed, fabricated, tested, and certified for use in the Russian Federation. The cask meets all applicable Russian Federation and international regulations/standards for use in the Russian military program. The RF has reported that the cask is being serially produced and is being utilized by the Russian Ministry of Defence to transport and store naval SNF.

The spent nuclear fuel transshipment/interim storage facility has been designed and accepted by the RF State Acceptance Commission for full operation. This will be the first transshipment facility in Russia for interim dry storage of spent nuclear fuel in transport and storage metal-concrete casks. This project has resulted in the development of new Russian standards and regulations for integrated transport and dry fuel storage of naval SNF. The development of this 40-tonne cask and storage facility has enabled the Russian Federation to remove a significant bottleneck in SNF transport and to expedite the Ministry of Defence program to dismantle its decommissioned Russian submarines. The RF military reported, at the AMEC 1.1-1 Promotional/Completion Event held in Murmansk, Russia on November 13, 2003, that the completion of this transshipment/interim storage facility allows the RF to double the current amount of SNF being transported from NW Russia to PO "Mayak" for reprocessing.

Completion of this cask and interim storage facility is a decisive step in creation of an integrated Russian SNF management network between Zvezdochka in Northwest Russia, Zvezda in Far East Russia and the central SNF storage and reprocessing center at PO "Mayak" in the Ural Mountains. This will also contribute to the first environmentally safe transport and storage system in Russia for SNF from decommissioned Russian submarines.

REFERENCES

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