

AMEC Project 1.1-1
Design, Construction, and Commissioning into Test Operation
of a Storage Pad for Transportable Metal-Concrete Containers
for the Interim Storage of Russian Naval Spent Nuclear Fuel

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PREFACE

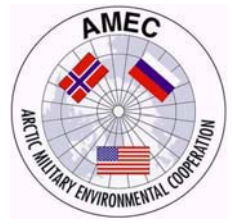
FFI has published the official close-out reports for three other projects completed within the framework of the Arctic Military Environmental Cooperation (AMEC).¹ The present report concerns the follow-up project to the first AMEC project and was originally written in 2004. It is published under FFI cover at this time mainly for completeness. Hopefully it will also contribute to spreading the word about a successful cooperation project beyond the inner circle of AMEC participants. The original close-out report was issued at the Naval Research Laboratory in the United States with reference number AMEC/PU/04--001.

Kjeller, February 2007

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Norwegian Project Officer for AMEC Project 1.1-1

¹ AMEC Project 1.1 *Development and Manufacture of a Prototype Transportable Interim Storage Container for Damaged and Undamaged Spent Nuclear Fuel* (FFI Report No. 2006/00048), AMEC Project 1.5 *Co-operation in Radiation and Environmental Safety* (FFI Report No. 2005/03620) and AMEC Project 1.5-1 *Radiation Control at Facilities: Application of the PICASSO System – Installation at FSUE Atomflot* (FFI Report No. 2005/03619).



AMEC/PU/04--001

**AMEC Project 1.1-1
Design, Construction, and Commissioning into Test
Operation of a Storage Pad for Transportable Metal-
Concrete Containers for the Interim Storage of
Russian Naval Spent Nuclear Fuel**

Final Closeout Report

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14. ABSTRACT Northwest Russia contains large quantities of spent nuclear fuel (SNF) from naval reactors 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 does not have the capacity for timely moving and reprocessing of all this fuel. Additional interim storage capacity is required. Many of the existing storage facilities being used in Northwest Russia do not meet international health and safety and physical security requirements. The removal, handling, interim storage, and shipment of the fuel pose technical, ecological, and security challenges.					
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INTRODUCTION AND PROBLEM DEFINITION

Northwest Russia contains large quantities of spent nuclear fuel (SNF) from naval reactors 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 does not have the capacity for timely moving and reprocessing of all this fuel. Additional interim storage capacity is required. Many of the existing storage facilities being used in Northwest Russia do not meet international health and safety and physical security requirements. The removal, handling, interim storage, and shipment of the fuel pose technical, ecological, and security challenges.

Norway and the United States have worked closely with the Russian Federation (RF) Ministry of Defence and the RF Ministry of Atomic Energy (now the RF Federal Atomic Energy Agency) to develop an integrated management system for interim storage of naval SNF in NW Russia. On the U.S. side, the work was headed by 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. The Norwegian efforts were managed by the Norwegian Defence Research Establishment (FFI) in cooperation with the Institute for Energy Technology. This SNF management system was developed with the support of the U.S. DOD Office of Cooperative Threat Reduction (CTR) and the Norwegian Ministry of Foreign Affairs as part of the Arctic Military Environmental Cooperation Program (AMEC). AMEC was established 1996 under a tri-lateral military agreement involving Norway, Russia, and the United States to work together in solving military environmental issues in the Arctic, primarily Northwest Russia.

AMEC Category 1.1 Projects address specific environmental issues associated with the removal, transportation, and storage of SNF from nuclear submarines being decommissioned in Northwest Russia. This category consists of two projects that constitute an improved and integrated SNF management system that meets RF and international requirements. The projects are: (1) development of a dual-purpose, metal-concrete 40-tonne container for both the transport and long-term storage (up to 50 years) of RF naval SNF (AMEC Project 1.1), and (2) development of the first transshipment/interim storage facility for these containers (AMEC Project 1.1-1).

AMEC Project 1.1, 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 with the designation TUK-108/1. Russia plans to use these containers for the transport and interim storage of military SNF from decommissioned nuclear submarines at naval installations in the Arctic and Far East.

AMEC project 1.1-1 was the design, construction, licensing, and commissioning of the first transshipment/interim storage facility in Russia. 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 December 2004. In

November 2003, as part of the facility “Completion Ceremony”, high-level representatives of the Russian Navy announced that the facility was ready for full operation. Russia has reported that the facility is now in full operation. The transshipment/interim storage facility was 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 this facility was 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” in the Ural Mountains 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 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 containers are moved from the interim storage facility onto the special rail cars designed for transporting such containers to PO “Mayak”.

TECHNICAL APPROACH AND ACCOMPLISHMENTS

The objective of AMEC Project 1.1-1 was to design, construct, and license a facility suitable for interim storage of up to nineteen of the TUK-108/1 40-tonne containers containing SNF. The transshipment/interim storage facility design includes a reinforced concrete foundation for storing the 40-tonne containers in a vertical position. The foundation is surrounded by concrete walls and a metal roof providing protection for the containers from snow and ice during the winter months. This allows access to the stored containers throughout the year, ensuring continuity in the fuel management process. The vertical concrete shield walls around the outer periphery of the foundation plate also minimize radiation exposure to site workers required to pass the storage facility. The shield walls extend upward to about two-thirds of the container’s height. A metal roof for weather protection covers the facility.

The AMEC Project 1.1-1 transshipment/interim storage facility at FGUP “Atomflot” meets all Russian design and regulatory specifications and IAEA standards and guidelines for the design, construction, and licensing of a transshipment storage pad for SNF. The storage facility is designed for at least a 50-year service life. Current plans are for loaded containers to be temporarily stored in the facility for 30-60 days, but no longer than 1 year. The storage facility is designed to withstand the extreme temperatures (-50°C to +32°C) of the Arctic, and a maximum seismic activity of 6 points on the MSK scale. The facility is located and designed to facilitate the use of existing equipment, railways, and transfer and handling facilities. The transshipment/interim storage facility is designed to accommodate both TK-18 transport containers and the new TUK-108/1 transport and storage containers while utilizing the existing container 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 facility construction activities began on site in September 2000. The major components of the transshipment/interim storage facility include: the concrete foundation plate and walls; metal roof and container coverings; dress out area and sanitary walkway; environmental/radiation monitoring system; physical protection system; and fuel accounting and

control system. AMEC Project 1.1-1 provided for all facility environmental/radiation monitoring required by RF standards and norms for operation of an SNF storage facility. The PICASSO system for data acquisition and presentation, installed by AMEC Project 1.5-1, provides additional environmental/radiation monitoring for the storage facility and integrates the readings from the AMEC Project 1.1-1 transshipment/interim storage facility with those from other facilities within the FGUP “Atomflot” complex. Figure 1 shows the TUK-108 prototype container in the Facility during the initial cold-testing of the Facility in June 2003.



Fig. 1. The TUK-108 Prototype Container 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 2 shows the completed storage facility undergoing a series of hot-tests in August 2003. Three RF TK-18 SNF containers 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 container 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. 2. Hot-testing of the AMEC Project 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 the transshipment/interim storage facility:

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

Considering that the new SNF transshipment/interim storage facility was to be regulated by the RF military while the total FGUP “Atomflot” site is regulated by the civilian Gosatomnadzor (now Rostekhnadzor), a special agreement had to be negotiated between the two regulatory Agencies.

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 3 shows the lowering of the TUK-108 prototype container, without fuel, into the completed Facility during the November 2003 AMEC Project 1.1-1 Promotional/Completion Event, which was 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 evaluated the facility in January 2004. The next step required obtaining the 21 approval signatures from all involved technical, regulatory, and construction organizations on the Act for the facility commissioning (State Acceptance Commission Report). The final requirement was obtaining the approval of the three key ministries involved with the facility design, construction, and operation (Rosatom, Ministry of Transportation, and Ministry of Defence).



Fig. 3. The TUK-108 Prototype Container (without fuel) being placed in the Storage Facility during the November 2003 Project “Promotional Event” noting the completion of the Facility construction.

EXPENDITURES FOR AMEC PROJECT 1.1-1

Design, construction, and commissioning costs:

Funds to the RF

Provided by Norway	\$322,075
Provided by U.S.	\$797,075
RF(In-kind Contribution)	<u>\$300,000</u> (Estimated)
Total for Project	\$1,419,150

Payment for all tasks in the approved Task Management Profile Plan have been made to the Russian Federation.

CONCLUSIONS

Under trilateral Norwegian, Russian and United States sponsorship, the AMEC Project 1.1-1 spent nuclear fuel transshipment/interim storage facility was designed, constructed and commissioned for operation. This is the first transshipment facility in Russia for interim dry storage of spent nuclear fuel in transport and storage metal-concrete containers. 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 the 40-tonne container and the transshipment/interim 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 submarines. At the AMEC Project 1.1-1 Promotional/Completion Event held in Murmansk, Russia on November 13, 2003, the RF military reported 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 project provides a physically secure, accountable, and an environmentally sound integrated solution that accommodates the requirements for increased removal and transfer of SNF from decommissioned RF submarines in the NW Russian Arctic to PO “Mayak” in central Russia or other long-term storage facilities.

All final approval signatures of the RF State Acceptance Commission were obtained in December 2004 allowing the facility to begin operation. Also, the final agreement and approvals for facility operation were obtained in December 2004 from the RF Federal Atomic Energy Agency (formally Minatom), the Ministry of Transportation, and the Ministry of Defence.

KEY PROJECT INDIVIDUALS

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PUBLICATIONS AND OTHER RELEVANT DOCUMENTS

1. “Management of Spent Nuclear Fuel from Decommissioned Submarines of Russia’s Northern Fleet”, Proceedings of Waste Management ’01 Conference, Tucson, AZ, February 25 – March 1, 2001.
2. “Management of Russia’s Spent Nuclear Fuel and Solid Radioactive Components”, Proceedings of Global 2001 – International Conference on “Back-end of the Fuel: From Research to Solutions”, Paris, France, September 9-13, 2001.
3. “Management of Russia’s Military and Civilian Spent Nuclear Fuel”, Proceedings of The 8th International Conference on Environmental Management, Bruges, Belgium, September 30 – October 4, 2001.
4. “Update on Cooperative Russian and U.S. Development of Spent Nuclear Fuel Transport and Storage Casks”, Proceedings of the INMM Spent Fuel Management Seminar XIX, Washington, D.C., January 9-11, 2002.
5. “Progress on Cooperative US and Russian Programs to Improve Environmental and Physical Security of Spent Nuclear Fuel in NW Russia”, Proceedings of Waste Management ’02 Conference, Tucson, AZ, February 24 - 28, 2002.
6. “Management of Russia’s Spent Nuclear Fuel and Other Radioactive Components”, Proceedings of the International Conference on Radioactivity in the Environment, Monaco, September 1-5, 2002.
7. “Completion of the First Spent Nuclear Fuel Transshipment/Interim Storage Facility in NW Russia”, Proceedings of Waste Management ’03 Conference, Tucson, AZ, February 23 – 27, 2003.
8. “International Cooperative Program Addressing the Management of Military SNF in Russia”, Proceedings of The 9th International Conference on Remediation and Radioactive Waste Management, Oxford, England, September 21-25, 2003.
9. “Commissioning and Testing of the First Integrated SNF Transshipment/Interim Storage Facility in NW Russia”, Proceedings of Waste Management ’04 Conference, Tucson, AZ, February 29 – March 4, 2004.
10. Official Technical Task Management Profile Plan agreed and signed by Norway, the Russian Federation, and the United States on July 15, 1998.
11. Official Project Protocols and Record of Discussions for all formal meetings.