

## CHALLENGES POSED BY RETIRED RUSSIAN NUCLEAR SUBMARINES

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The purpose of this paper is to provide an overview of the challenges posed by retired Russian nuclear submarines, review current U.S. and International efforts and provide an assessment of the success of these efforts.

The former Soviet Union constructed about 250 nuclear submarines, but unlike the United States made no plans for “cradle to grave” management of these nuclear submarines. Numerical superiority was imperative during the Cold War and consequently few submarines were retired as more capable platforms were constructed. This all changed when the Iron Curtain fell and close to 200 submarines were subsequently retired. The existing infrastructure ashore and afloat to dismantle the submarines and process the spent fuel and radioactive waste was already woefully inadequate and overtaxed. The challenge – what to do with the retired submarines, the spent fuel and radioactive waste? Although the spent fuel accounts only for 5% of the radioactive waste, it accounts for 99% of the radioactivity. It is estimated that 50% of the radiation potential in Northwest Russia comes from the spent nuclear fuel onboard the over 50 decommissioned submarines awaiting dismantlement. The poor material condition, lack of maintenance personnel, minimal preventive maintenance and in some cases civilian crews are of great concern.

When a nuclear submarine is retired, the process includes de-fueling, cutting out the reactor compartment and preparing it for long-term storage. Most submarines have two reactors, each reactor contains 180 – 280 fuel assemblies. The reactor compartments are sealed, buoyancy compartments attached and then stored afloat. A service ship transports the spent fuel to a land-based storage site, for eventual transportation to Mayak in the southern Urals for storage or reprocessing. The spent fuel is transported in special casks and railcars. The initial submarine dismantlement includes removal of deckhouse enclosures and other detachable parts while in the water, then dry dock or slip-way work is performed. Here, the reactor compartment is removed, missile compartment is cut out, and the bow and stern are removed. The remainder of the hull is sectioned and recycled as feasible. The challenges associated with each step are equipment and personnel for de-fueling, storage capacity, transport frequency and the need for advance payment to reprocess the fuel. Most of these challenges also apply to the liquid and solid radioactive waste processing steps. Until recently, one of the major bottlenecks has been the spent

WM '03, 1.10 The Arctic Military Environmental Cooperation Program,  
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fuel transport frequency by railway for reprocessing. The addition of a second transport train has increased the frequency of shipments. The dismantlement process also generates non-radioactive waste. Significant amounts of gas, aerosols and dust is released during dismantling polluting the air, soil and water with non-radioactive substances in the vicinity of the work sites. For example, the gas-plasma arc cutting torches pollute 35 million cubic meters of air with hazardous substances when cutting one ton of steel 20 mm thick. The protective equipment used by the workers frequently is ineffective. Improved ecological monitoring is required.

Current U.S. efforts include the dismantlement of over 40 Ballistic Missile Submarines (SSBN) as part of the Cooperative Threat Reduction (CTR) Program – over 20 SSBNs have already been dismantled. The primary CTR dismantlement sites are Zvezdochka and Nerpa in Russia's Northwest, and Zvezda in the Far East. These sites have state of the art dismantling equipment as well as spent fuel transfer and interim storage facilities. Russia is dismantling the remaining nuclear submarines, commonly referred to as General Purpose Submarines. Many of these submarines have been decommissioned for some time, some over 30 years. About 20 of these submarines are in danger of sinking due to low reserve buoyancy. Many of these submarines still have their nuclear fuel onboard. Russia can use the CTR provided dismantling facilities on a "not to interfere" basis with SSBN dismantlement. The Arctic Military Environmental Cooperation (AMEC) program has developed a prototype cask for SNF transport and storage. CTR has contracted for the serial production of this cask for the SNF from the dismantled Ballistic Missile Submarines. AMEC also has implemented projects that address the solid radioactive waste problem and personnel and ecological radiation monitoring at storage and waste processing sites.

A brief overview of the Arctic Military Environmental Cooperation (AMEC) Program follows. AMEC is a cooperative effort between the Ministries of Defense of Norway and Russia and the Department of Defense of the United States. The broad goal of the program is to mitigate the impact of military operations in the fragile Arctic environment while the specific goal addresses the cross-border nature of environmental problems, especially with respect to radioactive waste. Initial efforts focused on radioactive waste dumped in the Arctic Seas by the former Soviet Union, while current efforts address the source: spent fuel, liquid and solid radioactive waste from Russian nuclear submarines.

Projects address the following program areas: spent nuclear fuel management, liquid radioactive waste processing, solid radioactive waste volume reduction and storage technologies, radiation monitoring and personnel safety. Prototype development is the goal - mass production of the prototype will have to be accomplished using Russian, International or other U.S. funds. This is the approach used for the spent nuclear fuel project. The U.S. will purchase these casks for the spent nuclear fuel from the Ballistic Missile Submarines, while Russia will purchase these casks for the fuel from the General Purpose Nuclear submarines.

AMEC projects have been instrumental in changing the Russian nuclear waste storage system from a "wet" system, prone to failure, to a "dry" system used by most Western

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nations. Storage and transport of Spent Nuclear Fuel has been improved through the use of the AMEC developed "40 ton cask". This cask is now mass produced as the "TUK MBK 108" and is used by the Cooperative Threat Reduction Program for the Spent Nuclear Fuel from Ballistic Submarines while the Ministry of Atomic Energy uses the casks for the fuel from the General Purpose Submarines. The AMEC temporary storage/transshipment pad at RTP Atomflot will be placed in operation this year – the use of this pad will significantly reduce the transfer of Spent Fuel from service ship to railcar. This will also be the year that a comprehensive radioactive waste treatment and storage complex will be completed at Polyarnskiy, Shipyard 10. This complex will process 500 cubic meters of solid waste annually using the AMEC developed Mobile Pretreatment Facility and special steel transport/storage containers. The containers will be protected from the elements by light-weight storage buildings. Radio-ecological conditions at the site, as well as at the RTP Atomflot pad, will be monitored by the "Picasso" system, another AMEC project. Future plans include the development of a mobile liquid Waste Treatment facility for the site.

Although the AMEC Program operates on a relatively small budget – typically about \$2-3M per year – it has made a significant difference in addressing both radioactive and non-radioactive issues in the fragile Arctic environment. Not only has AMEC developed a spirit of cooperation and trust between the militaries and other agencies of the three nations, but it also provides viable technical solutions for those concerned with preserving the environment.

International efforts are coordinated through the IAEA Contact Expert Group (CEG). A variety of projects address the radioactive waste problems. A new initiative is focused on Andreeva Bay, where much of the Russian SNF and other radioactive waste is stored. Also, a fund to finance environmental clean-up projects in Russia is being established. Projects costing 1.3 Billion Euros have been identified, and donors so far have contributed 110 million Euro.

The IAEA established the CEG in 1996 to evaluate the environmental situation in Russia, to understand and provide multilateral support for a Russian strategy to address environmental issues and to provide resources to assist Russia as solutions are implemented. This multilateral group, with representatives from ten countries and four International Organizations, has progressively moved from problem identification to strategic evaluations and, currently, to evaluating alternative solutions to the environmental problems facing Russia.

AMEC has spent the past five years developing practical solutions to environmental problems at Russian military bases in the Arctic. These solutions include the development of a spent nuclear fuel storage and transport cask, a mobile solid radioactive-waste treatment/volume reduction facility, steel containers for the storage and transport of solid radioactive-waste, as well as constructive engagement on a broad variety of radioactive waste management and radiation safety topics. In October, 2001, the IAEA-CEG held a successful workshop at the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory that began the process of focusing

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multilateral projects on solutions to nuclear safety and environmental problems at the Andreeva Bay site, a former Russian Navy base now managed by the Russian Federation Ministry of Atomic Energy (MINATOM). The lessons learned, experience and the technologies from the projects developed under AMEC have many direct applications to the challenges facing MINATOM at Andreeva Bay. For this reason, the cooperation between AMEC and the IAEA-CEG can be beneficial to all parties involved.

The overall assessment is that there is still much to be done, but we are on the right track.