Nenoska Train Station: Russian Naval Officers prepare to escort US officials to railroad site.

Volpe Participation in

COOPERATIVE THREAT REDUCTION

Nuclear Missiles in the Former USSR

An impossible scenario as little as 10 years ago, American government personnel are now in Russia to help dismantle nuclear weapons. The situation has changed; once intractable foes are working together toward better technical and cultural understanding.

It is just past dawn at the Russian nuclear missile construction facility in Nizhnaya Salda, Siberia. A young Russian soldier blows warmth into his hands, delicately takes the controls of the large crane in which he sits, and concentrates on his task. He is to lift a 9,000 gallon container of highly combustible hydrazine rocket fuel into the air and lay it to rest on a specially designed flatbed railcar. Fellow soldiers are watchful as the container rises slowly from its position on the ground, swings through the air, and then rocks gently only feet above the railcar. Now the container eases down, and as it settles into position, everybody exhales.

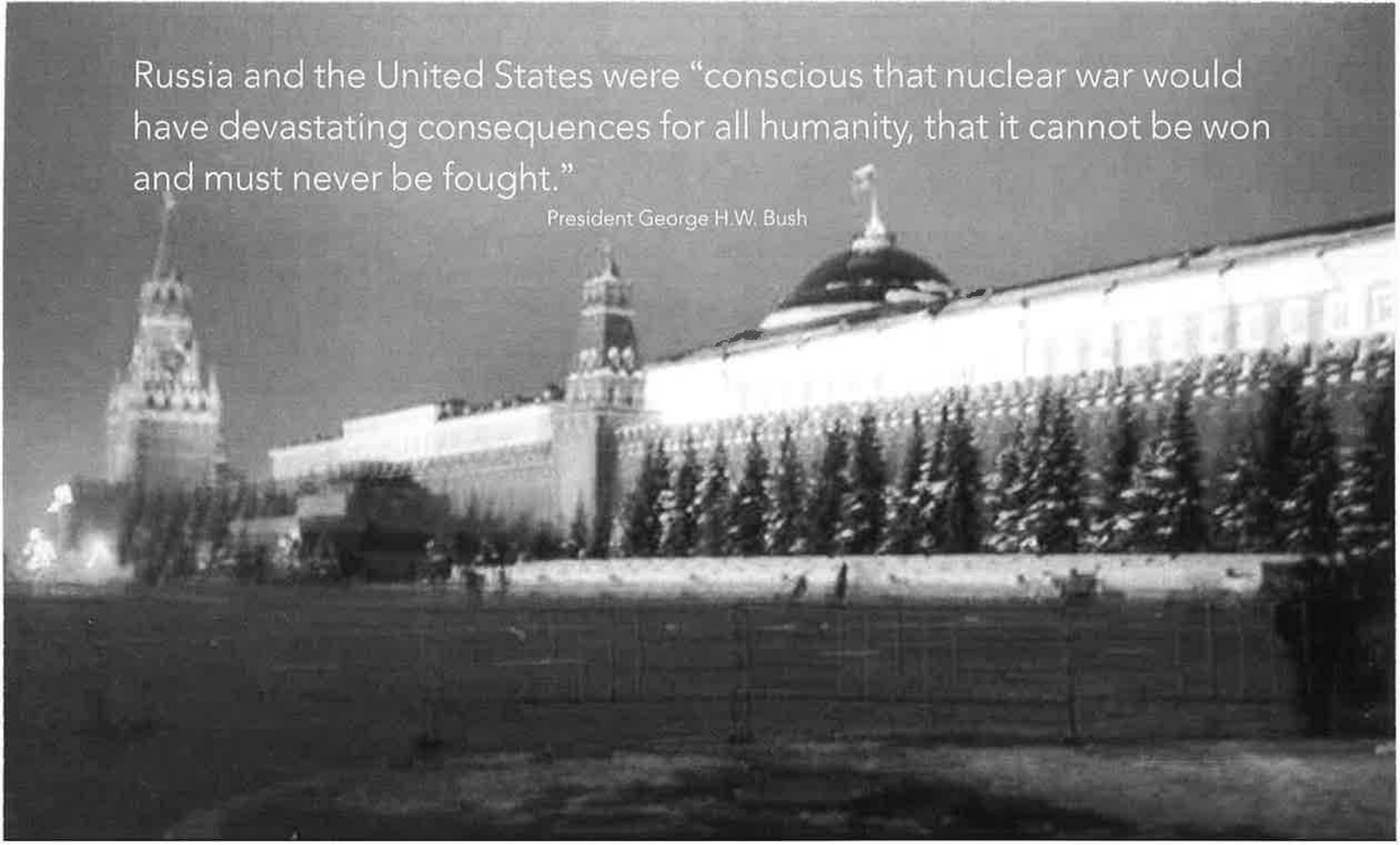
The fuel has just been removed from the motors of an SS-N-18 submarine launched ballistic missile and is being readied for transport to a fuel elimination facility. This missile, which once was mounted with 10 nuclear warheads, and hundreds of others like it will be dismantled as part of the Strategic Arms Reduction Treaty between the United States and Russia. Volpe Center rail transportation experts Ross Gill and Jim Lamond are playing an integral role in ensuring that the missile and fuel reach their final destinations safely.

Russian locomotive prepares to haul material and equipment to central unloading area.

START and START II

On July 31, 1991, President George H.W. Bush of the United States and Mikhail Gorbachev, then President of the Soviet Union, signed the Strategic Arms Reduction Treaty (START). Stating that both countries were "conscious that nuclear war would have devastating consequences for all humanity, that it cannot be won and must never be fought," this groundbreaking agreement between the world's two nuclear superpowers called for a reduction in the number of nuclear weapons deployed by each country. In setting limits for the number of intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles, heavy bomber aircraft, and warheads to be maintained, the treaty called for destruction of thousands of nuclear weapons and their delivery systems.

After the tumultuous breakup of the Soviet Union in 1991, the US and Russian governments, "desiring to enhance strategic stability and predictability, and, in doing so, to reduce further strategic offensive arms in addition to the reductions and limitations provided for in the START Treaty," signed the START II agreement. This pact, enacted in January 1993, updated the original treaty and further limited the number of weapons available to each country. The end of the Soviet Union also created new nuclear powers: because Soviet missiles were deployed in states other than Russia, the newly independent countries of Ukraine, Kazakhstan, and Belarus now ranked third, fourth, and eighth in the world in terms of nuclear weapon stockpiles.



In response to this potentially dangerous situation, US Senators Sam Nunn and Richard Lugar sponsored the Soviet Nuclear Threat Reduction Act. Renamed the Cooperative Threat Reduction Program, and administered by the Defense Threat Reduction Agency (DTRA), this legislation calls for the United States to provide assistance to the states of the former Soviet Union in disabling their nuclear, chemical, and biological weapons of mass destruction.

American DTRA team is greeted by the Russian Naval Commander at Nenoska.

The Problem

Beginning in 1993, DTRA worked with the governments of the former Soviet states to design a procedure for eliminating their missiles and fuel. The multi-step process called for destruction of a missile beginning with its removal from the silo, bunker, or submarine where it had been deployed. Each missile, with its fuel contained inside, would be moved to the factory where it had been originally built – with an intimate knowledge of each weapon, the missile designers and builders are the most qualified to disassemble them.

The entire process would involve several different types of missiles of various vintages. Solid fuel motors powered newer designs while earlier models contained either a combination of liquid and solid fuel or all liquid. Because these missiles are explicitly built to fly into the upper reaches of the atmosphere where oxygen is in extremely short supply, the motors require an oxidizer to complete the combustion reaction that powers the missile. The fuel and oxidizer would be removed from each motor and sent to a fuel elimination facility.

Solid fuel motors would be sent to a former rocket testing facility to be ignited until all of the fuel was burned off. After all fuel was removed from a missile and burned off from the motors, the component parts would be permanently destroyed. When the gyroscope from the missile guidance system was crushed, that weapon would be dismantled.

The plan made perfect technical sense, but the practical hurdles were large: missiles were to be collected from at least 10 installations across Russia, Ukraine, Kazakhstan, and Belarus, and moved more than 1,000 miles to destruction facilities.

Faced with the question of how to safely transport hundreds of dangerous fuel-laden missiles across thousands of miles, DTRA and Russian military planners immediately turned to the Russian rail system. With more than 50,000 miles of main railroad track in Russia, trains carry the large majority of freight in the country and more than 30 percent of passenger traffic. The rail system covers seven time zones, extending to nearly every corner of the country. It is well maintained and considered to be generally safe.

Typical Russian missile with multiple war heads, ready to be dismantled.

Missiles are moved by rail along the routes shown, for dismantling and decommissioning.

Volpe's Role in Rail Transport

Rail was clearly the answer for missile transportation, but not all pieces were in place to complete the job. At this point, the DTRA contacted Ross Gill of the Volpe Center's Advanced Vehicle Technologies Division to manage several aspects of the equipment planning and procurement. Gill's experience in equipment and process design, particularly while advising the US Air Force on jet fuel transportation issues, made him the perfect match for the job. And from the start, he was excited to be contributing to the historic process of nuclear disarmament.

"I grew up with bomb drills, the Cuban missile crisis, and Soviet missiles pointed at us," says Ross Gill. "To be part of the effort to reduce the threat of nuclear war was a thrilling opportunity."

Ross Gill's initial trip to Russia was in October 1993. His first night in the country made him think twice about working in the politically unstable Russia. "It was the night that the communists tried to take over the government by seizing the White House, Russia's main parliament building. As government troops stormed the building, we heard gunshots and tanks moving around Moscow. We decided to stick around the hotel for a few days."

When the dust settled, Ross Gill's Russian hosts insisted that all was back to normal. A bit shaken, but convinced that US assistance through the Cooperative Threat Reduction Program was more important that ever, Gill saw that it was time to get to work.

The first step in implementing the missile transportation protocol was making sure that all of the equipment was available. Railcars designed to carry the missiles existed – they had been originally used to transport newly built missiles from factories to military sites – but they had not been used in more than 15 years. Gill prescribed rehabilitation of these cars with new brakes, hoses, and internal rails on which the missile's cradle rests. Rehabilitation should include the on-board environmental systems to control temperature and humidity.

A support crane, which will be used for missile loading, is ready for shipment from Leipzig, Germany, to Russia.

At a Russian nuclear facility, a rail crew member prepares cars for container loads.

"To be part of the effort to reduce the threat of nuclear war was a thrilling opportunity."

Special containers were needed to transport the combustible and potentially poisonous fuel known as heptyl (unsymmetrical dimethyl hydrazine) and the highly corrosive oxidizer nitrogen tetroxide (N_2O_4). Gill suggested the use of intermodal containers for this task instead of modified rail tankers. An intermodal solution would allow the fuels to be transported over great distances by rail and then transferred to trucks for a shorter trip to the destruction facility. This eventual choice necessitated construction of not only the containers, but also flatbed cars adapted to carry them, and locomotive crane ilcars to lift the containers on and off the flatbeds.

Ross Gill oversaw the procurement of all three components. The 125 flatbed railcars were built in Abacon, Russia, based on the existing Russian 9004-series railcars. The standard design was modified slightly, with the deck improved from wood to steel and additions made to accommodate the fuel containers. The use of an existing railcar meant savings of up to a full year that would have been necessary to test and certify a new car for use on Russian tracks. Design and construction of the ISO compliant fuel and oxidizer containers was bid out worldwide resulting in a contract with a French firm – Arbel. The design was reviewed by Gill and the DTRA team, and 670 containers were ordered.

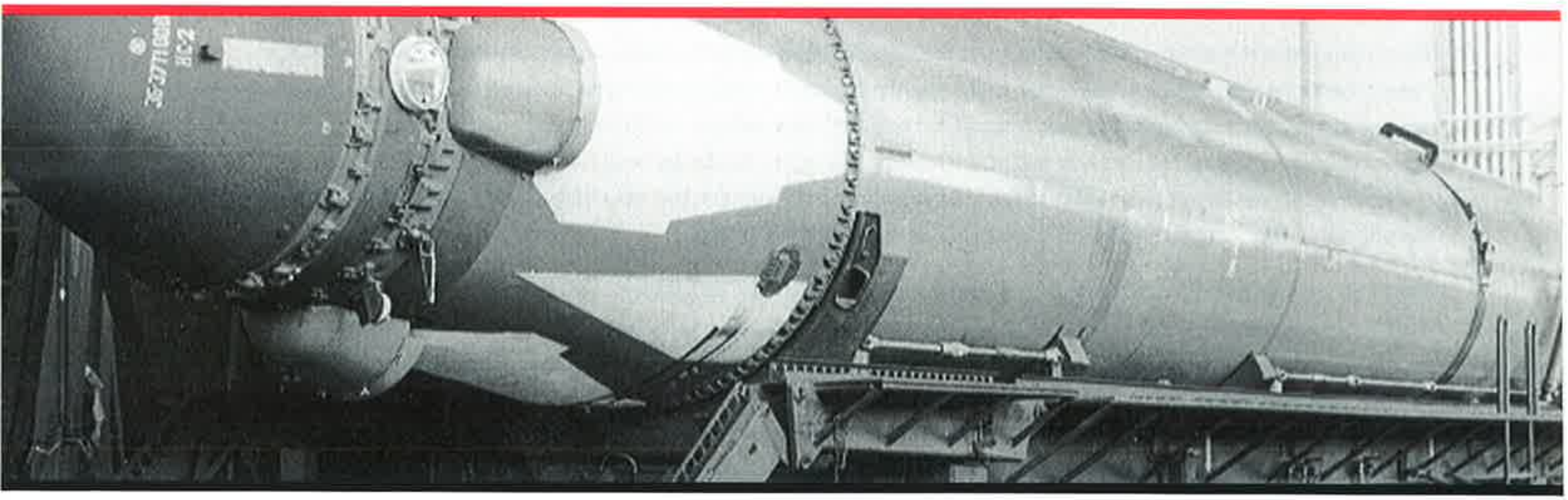
The team also ordered seven locomotive crane railcars that were built in Germany. Selecting the builder was not a difficult task, however, settling on the final design of the cranes required some cultural awareness. Ross Gill recommended a type of crane that automatically grips the four corners of an intermodal container, but the Russian team members wanted a design that required four soldiers to attach each container to the crane. In today's economically depressed Russia, the officers did not want to put more soldiers out of work.

At the same time that the team was overseeing the procurement of equipment, Ross Gill visited the installations from which missiles were to be removed. While the mammoth national rail system is well-maintained and was considered to be safe by the DTRA team, the first round of visits revealed that the little-used rail systems inside the military bases were not up to standard for moving the sensitive cargo involved in this project. With extensive experience in track inspection, the Volpe Center's effort refocused on inspecting and upgrading rail.

Jim Lamond of the Volpe Center's High Speed Ground Transportation Division joined the track inspection team in 1999. He recalls, "Most of the track was usable, but only by trains moving at very low speeds. We wanted to get the rails up to a consistent Class 2 standard," that is, Federal Railroad Administration Class 2 track, which is approved for freight transport at speeds of up to 25 miles per hour. The team first had to familiarize themselves with the Russian regulations for national building codes and standards. Upgrading tracks involved replacement of switches, rails, and ties, and frequently required the addition of ballast to firm the track bed.

Although the Russian rail system is the most extensive in the world and an indispensable component of the national transportation grid, the Russians do not have modern equipment that automatically inspects rail alignment. As a result, all track inspection – up to 10 miles of track at some sites – has to be done by hand.

Ross Gill has completed 14 inspections and Jim Lamond will soon be returning to Russia on his third inspection trip. The work is carried out by a small team consisting of Volpe Center staff, a Russian expert, a translator, and a US military officer who heads the team. Inspections typically require spending an average of 10 days at three military facilities for a specified missile.



Typical systems for mobility and field launch equipment.

Conclusion

Since 1993, with the assistance of Volpe Center staff, DTRA has coordinated the removal of 104 ICBMs from Kazakhstan, and the elimination of 165 ICBMs from Ukraine and 81 ICBMs from Belarus. Kazakhstan became a non-nuclear weapons state in April 1995; Ukraine completed its transition from the third largest nuclear power to a non-nuclear weapons state in June 1996; and the last nuclear weapons were removed from Belarus in November 1996. In addition, the equipment procured under Ross Gill's technical assistance has been used to dispose of 30,000 metric tons of heptyl fuel and 123,000 metric tons of oxidizer.

The important work of Volpe staff as part of the Cooperative Threat Reduction Program has been recognized by the Department of Defense. In 1995, Ross Gill received an Award of Excellence from the Secretary of Defense for his technical contributions to the entire project.

Volpe Center involvement in track inspections is expected to continue through 2007. Future efforts with the DTRA team will involve assisting Georgia, Kyrgystan, Moldova, Turkmenistan, and Uzbekistan with safeguarding weapons and technology related to nuclear, biological, and chemical weapons of mass destruction.

Safe and efficient reduction of the Russian weapons arsenal is making the world a better place to live. The Volpe Center is proud that Ross Gill and Jim Lamond are playing central roles in this historic effort.