

**High Explosive Detection and Destruction Technology Applications
For
Warhead Dismantlement Transparency**

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ABSTRACT

This study identifies transparency measures and procedures that could be applied to the process of High Explosive (HE) removal and destruction during warhead dismantlement. High Explosive detection and destruction technologies were analyzed and demonstrated to a joint U.S./Russian Technical team. These included:

- Gas analysis
- Neutron-neutron
- Neutron-gamma
- Neutron activation
- Hydro-jet cutting

Technical procedures and analysis of facility requirements for implementation were developed. An HE model assembly was also designed under this study to fully simulate all technical parameters expected to be encountered during the actual dismantlement process. This model was designed to meet the

- Required stability parameters of HE components
- Adaptability to recycling technology
- Physical-chemical, physical-mechanical properties

INTRODUCTION

With in the context of the Helsinki Summit Agreements, both the United States and the Russian Federation committed to "measures relating to the transparency of strategic nuclear warhead inventories and the destruction of strategic nuclear warheads". To help achieve a better understand of those objectives within the Russian Federation, Sandia National Laboratories under the auspices of the DOE's Office of Arms Control and Non-Proliferation (NN-42) Russian Lab to Lab Program, initiated a series of contracts with the Russian Nuclear Institutes to examine the topic of Warhead Dismantlement and Transparency. The primary contributor to the High Explosive detection and destruction analysis and technology development was the Zababakhin Russian Federal Nuclear Center of Technical Physics (VNIITF).

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As part of their analysis, they considered the destruction and elimination of non-nuclear components as part of a regime to enhance transparency of the overall dismantlement process. Two criteria were selected to assess the value of the non-nuclear components to be destroyed:

- Assurance of a high level of confidence that the nuclear warhead is destroyed as a weapon, and the impossibility of its later use or restoration,
- Assurance of a high level of confidence in the elimination of the warhead as a possible source of proliferation of nuclear weapons.

Using that criteria, the VNIITF investigators selected both high explosives and the warhead casing of ballistic missiles as candidates for technology development for detection and destruction. For this paper, we will only address the high explosive component.

HE DEMONSTRATION RESULTS

In April 1998, VNIITF technical experts conducted a series of technical demonstrations associated with HE detection and destruction at their local test site. The test facilities utilized and demonstrations performed by VNIITF replicated how transparency measures could be implemented over the process of verifying the presence of HE in containers and of physically cutting high explosive components. The experimental demonstration included:

- How the HE container is controlled up to the cutting facility
- How the cutting rooms and equipment could be certified
- How the HE would be positioned on the cutting stand
- How the HE would be shrouded
- How empty HE containers would be controlled
- How the transparency cutting plate would be installed under the cutting surface
- Remote monitoring of the cutting process
- Examination of the "transparency" cutting plate after the cutting process is complete
- How to confirm the HE is destroyed
- How to document the fact of destruction.

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VNIITF selected a plastic-bonded HMX sample as the model assembly for these demonstrations. HMX is a high-performance HE that is used in main charge HE formulations. For the purposes of the demonstrations, the model assembly was representative of types, formulations, and sensitivities of main charge HE with exception of its physical shape.

Four different HE detection technologies were demonstrated at the VNIITF test site. They selected a commercially available MO-2 type gas analyzer with the reported specifications of detecting all HE vapor traces even under field conditions. The detection technology is based on ion mobility spectrometry. Given that these demonstrations were performed at early morning outdoor temperatures, this particular sensor did not meet all our hosts' expectations.

For neutron-neutron technology, VNIITF selected their own device, the SRPS-2. The operational principle of this device is based on recording the thermal neutrons generated as a result of the HE interaction with neutron flow from ^{252}Cf radioisotope source. The system as designed presented a red light and a buzzer to indicate the presence of HE. As demonstrated, the detector was first triggered against the empty HE container and then tested against the container with the model assemble included to obtain the desired result.

Neutron-gamma technology was also presented as an option for the transparency regime. This technology was also Russian developed and utilized ^{252}Cf as its source of activation. This method detected HE through the identification of the presence of N-atoms. This technology was effective in identifying HE; however, its down side is its length of time required for accurate measurements and calibration.

VNIITF selected an in-house developed neutron generating system with a gamma spectrometer based on an IBM PC for the Neutron-activation demonstration. VNIITF has extensive experience with this technology; therefore, the demonstrations met their technical objectives.

For demonstrating how the HE components could be destroyed, VNIITF selected a hydroabrasive cutting technique. The abrasive water jet, which uses a compressed stream of high-pressure water and an abrasive material, is clearly one of the safest ways of cutting large HE shapes for the purposes of destruction. It minimizes heating of the HE and reduces the hazard of thermal ignition. This technology is not new; in fact, it has extensive U.S. commercial applications today.

Summary

It is clear from their technology demonstrations that VNIITF understands the application of these technologies for HE detection and destruction, that further refinement and system integration of the technologies is required, that monitoring the process of HE detection and destruction is intrusive, and that monitored HE detection and destruction must be integrated with upstream transparency measures to ensure high confidence of warhead dismantlement and irreversibility of the process. Issues associated with security, classification and detection technology system reliability (e.g. false positives) all need to be resolved if the system is to be licensed and certified for implementation at Russian serial production facilities.