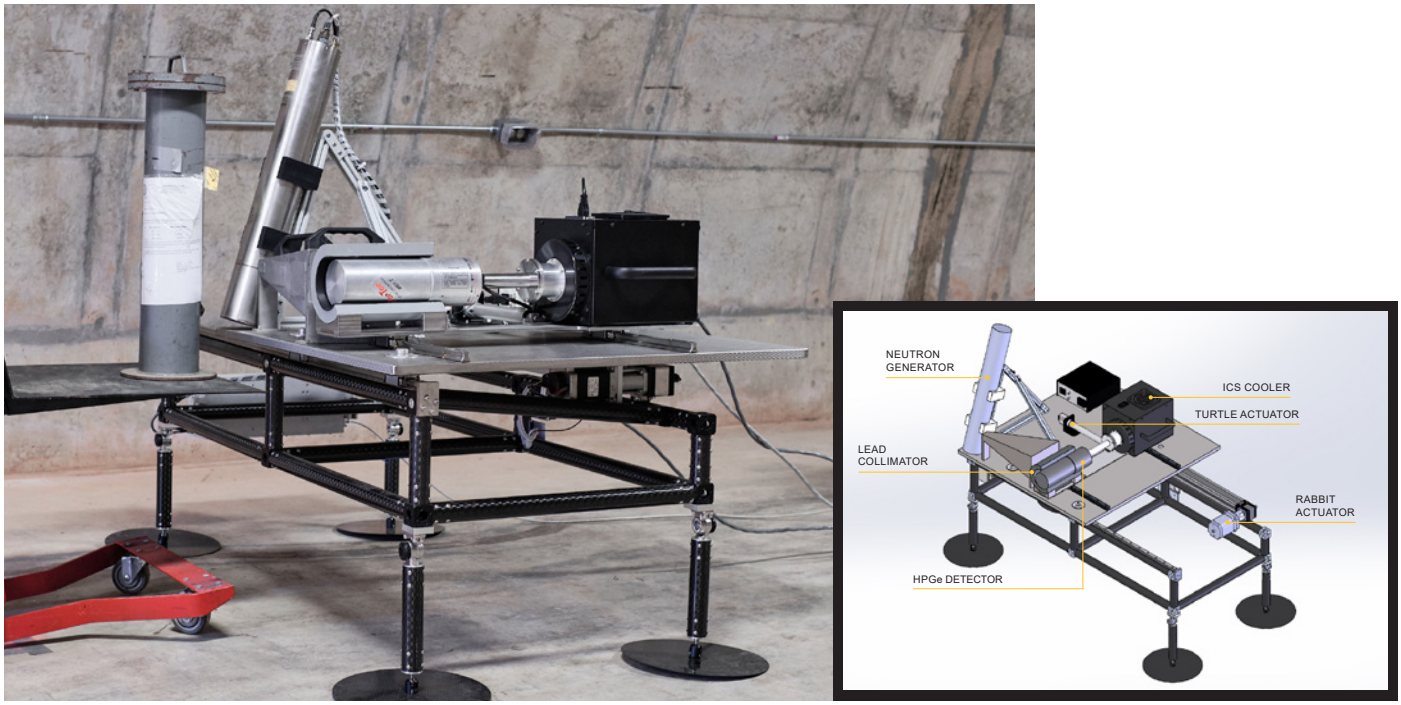
NON-INTRUSIVE THREAT DETECTION SYSTEM (NITDS)



A recovered munition in an overpack container is positioned close to the NITDS neutron generator. The neutrons penetrate the munition and interact with its contents, causing the atomic nuclei of the contents to emit gamma rays, which are detected by the system. Each element has a unique gamma ray signature that is used to identify the chemical fill.

The U.S. Army Chemical Materials Activity Recovered Chemical Materiel Directorate (CMA RCMD) recruited the Non-Intrusive Threat Detection System into its suite of fielded assessment equipment in November 2020. As one of CMA RCMD's assessment technologies, the NITDS can assess an item of interest and determine its chemical fill without opening it.

The NITDS utilizes neutron-activation technology to accomplish its task. A recovered munition is positioned close to the system's neutron generator. The generator produces neutrons that penetrate the wall of the munition and interact with the item's contents. This interaction causes the atomic nuclei of the contents to emit gamma rays, which are detected by the system. Each element has a unique gamma ray signature that is used to identify the chemical fill.

The NITDS uses a Deuterium-Tritium (DT) neutron generator, which produces neutrons at a higher energy than systems utilizing a Californium (Cf) energy source, such as CMA RCMD's Portable Isotopic Neutron Spectroscopy (PINS-Cf). The higher-energy neutrons produce distinct reactions, providing additional information used to determine the chemical fill of the recovered item. The NITDS also cycles the neutron generator on and off, which improves detection of delayed reactions from elements such as oxygen and fluorine that would normally be obscured by background noise.

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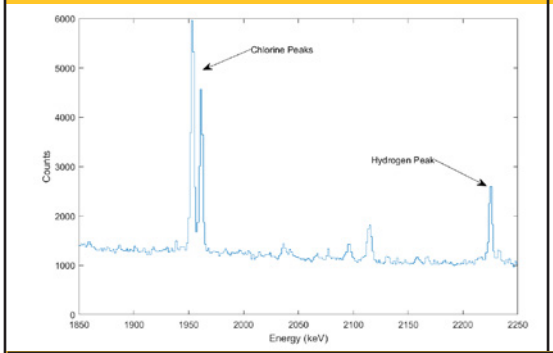
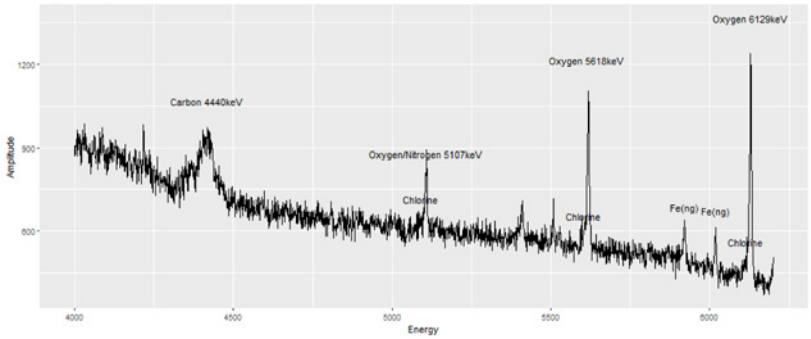
NITDS (CONTINUED)

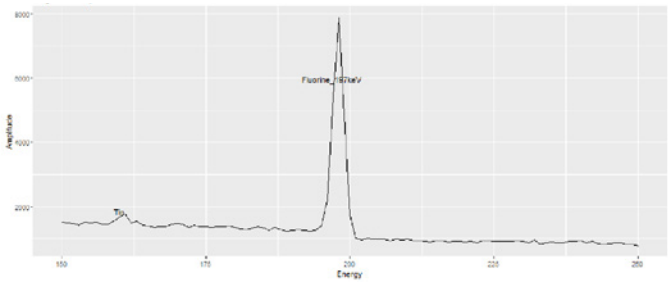
Spectrum 1



Spectrum 2



Spectrum 3



The PINS-Cf produces lower-energy neutrons which offers better detection of hydrogen and thermal capture reactions. ***Spectrum 1*** *shows a PINS-Cf spectrum for a 4.2" mortar with HD fill. The NITDS produces higher-energy neutrons which improves detection of elements such as oxygen and carbon, and utilizes delayed activation reactions to improve detection of elements such as fluorine.* ***Spectra 2*** *and* ***3*** *show a NITDS spectrum for a GB simulant.*

The NITDS operates in two phases. The first phase consists of continuous neutron bombardment of the recovered item, similar to the PINS-Cf operation, for approximately 45 minutes. The second phase runs for approximately 22 minutes and cycles the neutron generator's power -- 30 seconds on and 30 seconds off. When the generator cycles on, the target is close to the generator and away from the gamma ray detector. When the generator cycles off, the NITDS moves the detector closer to the target. Cycling the power to the neutron generator and shifting the placement of the detector is what enables the NITDS to capture delayed reactions.

CMA RCMD first utilized the NITDS in September 2019 during operations to assess items recovered at Pine Bluff Arsenal, Arkansas. The NITDS was deployed for 17 recovered items, which were selected by CMA RCMD to be a mix of items most likely to contain chemical warfare materiel, possible white phosphorous-filled items (which can be disposed of by PBA), and a few empty rounds. Of the 17 items, seven were determined to contain chemical warfare materiel, and CMA RCMD destroyed them during Pine Bluff Explosive Destruction System operations in July-August 2021.

CMA RCMD will deploy one or both of the PINS-Cf and NITDS systems for assessment operations based upon historical knowledge of the recovery site, the type of munition, and a list of probable fills for the item. Each chemical agent has a distinct elemental composition that is better detected at certain energies. When bombarded with neutrons, elements that undergo higher-energy reactions and delayed reactions are more easily detected by the NITDS, while elements that undergo lower-energy reactions are more easily detected with the PINS-Cf.