Homeland Security
Science and Technology

TechNote

U.S. Department of Homeland Security
SAVER
System Assessment and Validation for Emergency Responders

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions.

Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercial equipment and systems and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL).

The SAVER Program is supported by a network of technical agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

For more information on this and other technologies, contact the SAVER program by e-mail or visit the SAVER website.

E-mail: saver@hq.dhs.gov
Website: http://www.firstresponder.gov/saver

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NUSTL

Handheld Radionuclide Identification Devices (RIDs)

When first responders detect radioactive materials using screening devices such as personal radiation detectors, survey meters, or portal monitors they use handheld radionuclide identification devices (RIDs) to identify the specific radionuclides present at the scene. Law enforcement personnel use RIDs to distinguish between nonthreatening radioactive materials, such as industrial or medical radionuclides, and high-level threats, such as radiological dispersion devices or improvised nuclear devices. Firefighters, hazardous materials response teams, and other first responders use RIDs to identify the specific radionuclides present at the scene to help determine how to minimize the impact of the event.

Overview

Many radionuclides emit gamma rays having a characteristic pattern of energies and intensities that distinguishes them from other radionuclides. RIDs identify the radionuclides present in an unknown radioactive source by identifying their characteristic gamma ray emission patterns.

Figure 1. A Handheld RID
Photo courtesy of Berkeley Nucleonics Corporation

A key RID component is its gamma-ray detector, which converts the gamma rays striking it into a signal that can be electronically processed and analyzed.

Gamma-ray detectors can be made of one of two types of materials: scintillators or semiconductors. Scintillator detectors produce light pulses when struck by gamma rays, while semiconductor detectors produce electrical pulses. Commonly used scintillator detector materials include thallium-doped sodium iodide [NaI(Tl)], cesium iodide (CsI), and lanthanum bromide (LaBr); commonly used semiconductor detector materials are high-purity germanium (HPGe) and cadmium zinc telluride (CZT). The amplitude of the pulses produced in either detector type is proportional to the energy of the incident gamma rays, and therefore the energy of gamma rays striking the detector can be determined by measuring the amplitudes of the detector pulses. The RID's electronics count the detector pulses, measure their amplitudes, and process this data into a plot of the number of gamma rays detected at different energies; this plot is referred to as a gamma-ray spectrum. A built-in spectrum analysis program then automatically identifies the radionuclides represented in the measured gamma-ray spectrum by comparing it to an internal radionuclide gamma-ray spectrum library.

Features and Use Considerations

Two important characteristics of RIDs are sensitivity and energy resolution. Sensitivity indicates how efficiently gamma rays are detected; with increasing sensitivity, gamma ray emitting radionuclides can be detected in smaller quantities, at greater distances, and in shorter periods of time. Sensitivity is determined by the size of a RID's gamma-ray detector, the material it is made of, and the energy of the gamma rays striking the detector. As a general rule, for gamma-ray detectors made of the same material, the larger the detector, the better its sensitivity.

Energy resolution indicates the sharpness of peaks in the gamma-ray spectra obtained with a RID. RIDs based on different detector materials have significantly different energy resolutions. With better energy resolution, measured gamma-ray peaks become narrower and taller; consequently, energetically similar gamma rays are more likely to be distinguishable from one another, and minor spectrum peaks are more likely to be detectable. RIDs with better energy resolution thus provide more detailed information about the pattern of gamma rays emitted by radioactive sources. This may translate into an improved radionuclide identification capability by making it possible to detect minor spectrum peaks that are particular to a specific radionuclide, as seen in Figure 2.

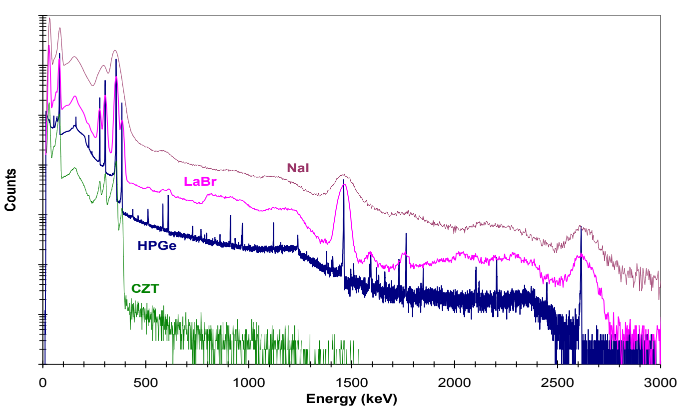

Figure 2. Ba-133 Gamma-ray Spectra Obtained with NaI(Tl)-, LaBr-, HPGe-, and CZT-based RIDs.

RIDs based on NaI(Tl) detectors are probably more widely used than any other type, but they have poorer energy resolution compared to some other RID types. CsI RIDs have similar energy resolution to NaI(Tl). LaBr and CZT RIDs offer improved energy resolution compared to NaI(Tl), but are more costly. Due to manufacturing challenges, CZT gamma-ray detectors tend to be smaller than other detector types; consequently, CZT RIDs tend to have lower sensitivities compared to other RID types, particularly for high-energy gamma rays. Some RID models contain two detector types, e.g., CZT and NaI(Tl), to take advantage of their relative strengths with respect to sensitivity and energy resolution. HPGe-based RIDs have significantly better energy resolution than the other RID types but are substantially more costly. HPGe detectors must be cooled to an extremely low temperature with an internal refrigeration system in order to operate. The size and weight of the refrigeration system makes these RIDs less portable than other RID types, and while other RID types are typically ready to operate in a few minutes from a dead start, it may take 30 minutes or more to cool an HPGe-based RID to an operable state.

Some RID models are equipped with neutron detectors to enhance their ability to detect certain neutron emitting special nuclear material (SNM) radionuclides, which are the key components of nuclear weapons. RIDs may also contain radiation dose rate meters to allow users to determine whether ambient radiation levels present a health threat.

Organizations assessing different RID models for purchase may wish to consider how well they conform to the American National Standards Institute ANSI N42.34-2006 standard, which specifies a wide range of features of RIDs used for homeland security applications. Specifications relating to field usability include the ability to operate on internal batteries for at least 2 hours, the ability to operate on external direct current power sources, instrument displays that are readable under different lighting conditions, manual controls that can be operated while wearing gloves, and the ability to export acquired spectra via a communications port or removable memory card. Specifications relating to radionuclide detection include the ability to identify radionuclides commonly used for medical and industrial purposes, naturally occurring radionuclides sometimes detected in commercial products such as ceramics and fertilizers, and SNM radionuclides.

Gamma-ray spectra can be difficult to analyze when radionuclides are stored in shielding, or when a radioactive source contains many different radionuclides. When presented with challenging spectra, RID isotope identification software may fail to identify the radionuclides present. In such cases, an important resource available to first responders is the Radiological Triage Program of the National Nuclear Security Administration (NNSA), which provides highly trained gamma-ray spectroscopists on a 24/7/365 basis to perform analyses of RID gamma-ray spectra. First responders can transmit RID spectra to Radiological Triage via the Internet and expect to receive analysis results within an hour, free of charge. More information can be obtained by calling the NNSA at 1-800-586-5000.