Homeland Security

TechNote

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

The U.S. Department of Homeland Security, Preparedness Directorate, Office of Grants and Training (G&T) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders in performing their duties. The mission of the SAVER Program is to

- Provide impartial, practitioner relevant, and operationally oriented assessments and validations of emergency responder equipment.
- Provide information that enables decision-makers and responders to better select, procure, use, and maintain emergency responder equipment.
- Assess and validate the performance of products within a system, as well as systems within systems.
- Provide information and feedback to the user community through a well-maintained, Web-based database.

The SAVER Program established and is supported by a network of technical agents who perform the actual 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?"

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Radiation Survey Meters

Background

Radiation survey meters are portable, hand-held radiation detectors that can be used by emergency responders: law enforcement, fire fighters, hazmat team members, and healthcare professionals, during interdiction or response to radiological incidents. Survey meters are physically larger and heavier than radiation pagers and are not intended to be worn by a person. However, they may be carried in emergency vehicles (e.g., fire trucks, squad cars, or ambulances). Survey meters have bigger internal radiation detectors and therefore, they offer more detection sensitivity than radiation pagers. Some survey meters have a read-out unit with interchangeable probes for detecting different types of ionizing radiation (e.g., alpha, beta, and gamma). In the hands of emergency responders, survey meters would be primarily used to verify and confirm the readings of radiation pagers, locate radioactive source or material, or provide numerical value of the measured quantities to estimate the scale of the radiological problem. In the absence of radiation pagers, survey meters equipped with alarming capabilities can provide an early warning of the presence of radiation, reducing the risk of harmful health effects or radiation exposure.

Fundamentals

Ionizing radiation produces charged particles (i.e., ionization), or produces micro flashes of light (i.e., scintillations) that can be detected by measuring these charges or scintillations with specialized instrumentation.

Different types of radiation carry different amounts of energy and penetrating powers. Alpha radiation can travel 2 inches in air and can be stopped by a piece of paper, but can cause the most damage to human organs if alpha-emitting radioactive substances enter the human body. Beta radiation can travel several hundred feet in air and can be stopped by most protective clothing. Skin contamination and inhalation are the primary paths of exposure from beta radiation.

Gamma is the most penetrating radiation and can be stopped only by several inches of lead or several feet of concrete and other high-density materials.

More information on radiation and radiation protection basics can be found on the Health Physics Society (HPS) or Environmental Protection Agency (EPA) home pages listed at the end of this note.

There is no detection system that can detect all forms of ionizing radiation. As gamma is the most penetrating form of radiation, most early detection devices are optimized to detect gammas first. Radiation detection is based on measuring the electric signal produced by radiation in gases using Geiger-Muller (G-M) tubes; semiconductors, such as Cadmium-Zinc-Telluride (CdZnTe) and high purity germanium (HPGe); or scintillating crystals, such as Sodium Iodide (NaI) and Cesium Iodide (CsI).

Alpha radiation is detected with Zinc-Sulphide (ZnS) scintillator, with a measuring window protected by a very thin mylar sheet. Beta radiation probes are energy-compensated G-M tubes.

Typical survey meters may consist of

- Read-out unit that contains a power source for external probes, handles the display and alarms, and sometimes is equipped with internal radiation detectors.
- Specialized smart probes for exposure rate measurements and/or contamination detection.

Ludlum Response Kit (left to right): Gamma Scintillator probe, energy-compensated G-M probe, survey meter, G-M pancake probe

Performance Factors

Radiation survey meters are designed as primary instruments to accurately measure radiation exposure and to detect radioactive contamination. The most common portable survey meters are those with G-M tubes and with scintillation detectors. The desirable features for radiation survey meters with G-M tubes are the audio output (i.e., clicks), reliability, and large diameter or large surface area probes. The survey meters optimized for gamma detection contain at least 1-inch diameter × 1-inch thick sodium iodide NaI scintillator and can detect small quantities of radioactivity, important for law enforcement interdiction. However, the higher sensitivity of the survey meter may result in saturation in the presence of large quantities of radioactive materials, or during rescue operations following a major radiological incident (i.e., exposure rates >10 R/h). Survey meters are well suited for emergency responders and hospital staff who may need to quickly determine if small amounts of radioactive substances or radioactive contamination are present. For proper operation, training must be provided as successful contamination monitoring with survey meters requires specific techniques.

The American National Standards Institute (ANSI) Standard N42.34-2003, "American National Standard for Portable Radiation Detection Instrumentation for Homeland Security," describes performance criteria for portable radiation survey meters, but only in their response to gamma radiation. There is no current ANSI standard for contamination control. The standard distinguishes two kinds of survey meters: Type 1 for detection and interdiction and Type 2 for hazard assessment. Type 1 instruments must operate in the range of 0 to 1 mR/h and Type 2 in the range of 0.1 mR/h to 1000 R/h. The size and weight of survey meters should be limited to total volume of 1 ft^3 and less than 10 lb. The construction of the instrument shall be rigid, shock resistant, splash proof, and dust resistant. The battery life should be sufficient to cover, at a minimum, a 24-hour shift, and should have a battery status indicator.

Applications

Radiation survey meters are primarily used as follow-up to alarms from radiation pagers or portal monitors to localize radioactive sources or to detect the presence of radioactive contamination.

Emergency responder performing contamination survey.

If equipped with gamma sensitive probes (internal or external), a survey meter is useful for the following:

- Establishing control zone boundaries.
- Controlling personnel exposure.
- Assessing package integrity.
- Locating sources of radiation.

The purpose of a contamination survey is to locate radioactive material in unwanted locations. A survey meter with alpha/beta probe is useful for the following:

- Locating contamination on personnel and equipment.
- Determining the effectiveness of decontamination.
- Verifying contamination control boundaries.
- Determining the extent and magnitude of a contaminated area.

For additional applications, see the EPA's Radiation Protection Basics or the HPS's Radiation Basics.

Limitations

Radiation survey meters do not have isotope identification capabilities, but some of them can determine types of ionizing radiation (e.g., alpha, beta, or gamma). Their operation could be more complex than radiation pagers and require more intensive training for proper use and operation. Survey meters are more expensive than pagers, especially if equipped with interchangeable probes. Most of the current commercially available survey meters have measuring ranges that cover lower (classified by ANSI Standard N42.33 as Type 1) exposure rate range (up to 5 mR/h) that are excellent for interdiction or location of radioactive materials. However, Type 1 survey meters may saturate or give false readings at levels that emergency responders may experience in large "dirty bomb" explosions or serious radiological events. Such situations require survey meters classified by ANSI Standard as Type 2. The decision to purchase Type 1 or Type 2 survey meters should be based on their ultimate applications. The cost of a typical survey meter is in the range of $2,000 to $4,000.

Resources

IEEE ANSI N42.33-2003, "American National Standard for Portable Radiation Detection Instrumentation for Homeland Security."

Radiation Basics (http://hps.org/publicinformation/ate/faqs/radiation.html).

Radiation Protection Basics (http://www.epa.gov/radiation/understand/protection_basics.htm%20).

SAVER is sponsored by the U.S. Department of Homeland Security, Preparedness Directorate, Office of Grants and Training.

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