Homeland Security

TechNote

SAVER

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 Pagers

Background

Radiation pagers are small alarming personal radiation detectors worn on a person, that provide visual, audio, or vibration alarm warning about the presence of elevated radiation. Radiation pagers should be worn close to the body and left on constantly (like communication pagers). Ionizing radiation emitted by radioactive material (i.e., source) cannot be detected by human senses, but can cause severe health effects by damaging cells in the human body. Such warnings have to come well before the emergency responder is exposed to health-threatening levels of radiation. Radiation pagers can alert emergency responders to the presence of radioactivity before coming in contact with radiation.

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.

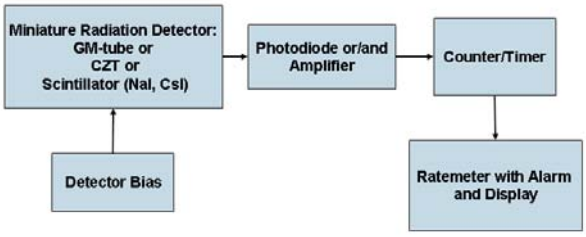
Different types of radiation carry different amounts of energy and penetrating powers. Alpha radiation can travel 2 inches in air and can be stopped by a piece of paper, but can cause the most damage to human organs if alpha-emitting radioactive substances enter the human body. Beta radiation can travel 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 gamma 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).

Components of a typical radiation pager are:

- Detecting element: (G-M tube/CdZnTe/NaI/CsI).
- Preamplifier-Amplifier.
- Power source (battery).
- Display and/or alarms: visual, audio, vibration.



Performance Factors

Radiation pagers are designed to respond only to highly-penetrating ionizing radiation (e.g., gamma or neutron) and cannot detect alpha or beta radiation. Most pagers will have predefined, or user-defined alarm settings for radiation dose or exposure received by a person wearing the pager. The pager's display can show real-time exposure rate in physical units of micro- or mili-Roentgens per hour (μR/h, or mR/h), numerical values (e.g., 1 to 9: 1 safe, 9–stay away), or color warning lights [e.g., light-emitting diodes (LEDs)]. Performance criteria for radiation pagers are defined in American National Standards Institute (ANSI) Standard N42.32-2003, "American National Standard Performance Criteria for Alarming Personal Radiation Detectors for Homeland Security." The standard requires, among other factors:

- Minimum alarm response level: 50 μR/h.
- Overall device dimensions: 20 × 10 × 5 cm, 400 grams.
- Operating temperature: -20°C to 50°C.
- Mechanical shock: correct operation after drop from 1.5 m onto concrete surface.

The ANSI standard also requires a pager alarm annunciation to include visual, audio, or vibration that can be seen, heard, or felt under field conditions in emergency response situations while wearing protective clothing. The battery life should be sufficient to cover, at a minimum, a 24-hour shift and should have a low battery indicator.

Applications

Radiation pagers are used as personal alarming devices for early detection. They respond only to relatively high radiation levels and are primarily used to provide early warning that a significant quantity of radioactive materials emitting gamma or gamma and neutron radiation is

present. Emergency responders can use radiation pagers to alert them to the presence of radiation before exposure when responding to fire emergencies, vehicle stops, vehicle accidents, perimeter surveillance, or declared radiation emergencies. Sometimes, radiation pagers are used by law enforcement for interdiction purposes; however, such application requires caution since pagers have small radiation detectors and therefore, limited sensitivity. Radiation pagers should be followed up by further investigation with appropriate instrumentation, such as more accurate survey meters or radioisotope identifiers, using established protocols.

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

Limitations

Radiation pagers do not have isotope identification capabilities and record every hit by a gamma photon or neutron as an electric signal. They respond to the presence of any gamma-emitting radioactive material at sufficient quantities, whether it is a legitimate commercial radioactive source (e.g., Potassium-40 in large shipment of ceramic tiles or a person who has had a medical stress test using Thallium-201) or a potential terrorist weapon. Therefore, its use is limited to indicating the presence of radioactive materials and providing early warnings. They are not sensitive and cannot detect airborne radioactive dust containing material that produces alpha radiation, such as uranium or plutonium. The cost of a typical pager is around $1,000.

Resources

IEEE ANSI N42.32-2003, "American National Standard Performance Criteria for Alarming Personal Radiation Detectors 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).

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