FEMA 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. The SAVER Program conducts objective operational tests 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).

Information provided by the SAVER Program will be shared nationally with the responder community providing life- and cost-saving assets to federal, state, and local responders.

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, please see the SAVER website or contact the SAVER Program Support Office.

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Dosimeters for Response & Recovery

Dosimeters are small radiation detectors worn on the body that monitor the personal accumulated radiation dose received by an individual from external radiation sources. They are not designed to account for inhaled or ingested radioactivity, and while some can measure beta or neutron radiation, gamma radiation is the primary focus of this TechNote. Various types of dosimeters are routinely used by nuclear power plant or hazardous material workers to ensure that the radiation dose they receive does not exceed annual occupational dose limits. Some states have dosimeters stockpiled for emergency use. In the event of a radiological dirty bomb or an improvised nuclear device attack, these dosimeters could be used by responders for worker protection and tactical decisions. They differ from other radiation devices that alert a responder to the presence of radiation, such as radiation pagers, which may not be calibrated to measure individual dose.

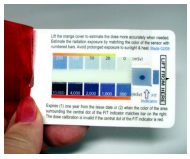
Technology Overview

Several dosimeter technologies are available for different applications.

Pocket ion chamber (Quartz fiber electroscope)

Also known as a pencil dosimeter, this cylindrical device contains a thin quartz or carbon fiber aligned to a radiation exposure scale. A manually operated charger is used to zero the reading before use by establishing an initial electrostatic charge on the fiber. The fiber is deflected when radiation ionizes the air inside, and the scale can be read by looking through one end while holding it up to light.

Radio-chromic dosimeter



Also called colorimetric dosimeters, these have radiation sensitive film mounted in a credit card format. The film darkens with radiation exposure and a color matching scale printed on the card can be used to visually estimate the radiation dose received.

TLD and OSL dosimeter

Thermoluminescence dosimeters (TLDs) and optically stimulated luminescence (OSL) dosimeters contain materials that trap electrons released during radiation exposure which can later be freed by stimulation with heat (TLD) or light (OSL). This stimulation is done in a processing laboratory and the resulting light emission provides a measure of the radiation dose received. TLDs and OSL dosimeters are widely used in worker radiation safety programs.

Electronic dosimeter

Battery powered dosimeters have a digital readout and may have an audible alarm. Some contain a small Geiger Mueller (GM) tube; others use cesium iodide scintillators or silicon semiconductors.

Features

These features depend on the dosimeter technology:

- Readout
- Dose sensitivity
- Format
- Cost

Pocket ion chambers have an analog scale which can be read by the wearer. They are available in different models which separately cover routine and emergency dose levels; precision would depend on the model used. They do not contain batteries and are designed to be clipped into a breast pocket. They are relatively inexpensive and durable but the reading can be sensitive to impact.

Radio-chromic dosimeters are also field readable and can be carried in a wallet or ID holder. They are intended to indicate emergency dose levels rather than lower doses in routine occupational monitoring. Variability in individual interpretation of the color may affect precision. They do not require batteries and are relatively inexpensive and durable, with a shelf life of about one year. They include a protective cover to avoid continuous exposure to bright light.

TLD and **OSL** devices do not provide a visual display of the accumulated dose. They must be processed with specialized equipment before the dose is known. They measure a wide dose range from routine through emergency levels with high precision. Badge designs are clipped on to clothing, while cards can be carried with ID. The have no batteries and the unit cost is relatively inexpensive. Commercial dosimetry services can be contracted to supply dosimeters on a regular basis (e.g. quarterly or annually) and read out the returned dosimeters as required. Turnaround time for dosimeter results is typically about 1-2 weeks but arrangements can be made for faster turnaround in emergencies. Some national laboratories and nuclear power plants operate their own dosimetry laboratories on site.

Electronic dosimeters record accumulated dose and can also give real time dose rate information to the wearer. They typically measure a wide dose range from routine to emergency levels with high precision. Formats include badge and pager sized, designed to clip on to clothing or to be carried in a pocket. Batteries are required and some electronic dosimeters may be sensitive to interference from radiofrequency electromagnetic fields. The unit cost (e.g. a few hundred dollars) can be significantly greater than that for other dosimetry technologies.

Applications & Performance Considerations

The relative importance of dosimeter features will depend on the intended purpose.

Field readable dosimeters could aid tactical decisions in early phase response. After a radiological release, local guidelines would set the dose limit that a responder should receive for turn back, life saving or property recovery operations. The responder could decide whether to enter or stay out of the radiation area based on his dosimeter's accumulated dose reading. In this case, the dosimeter sensitivity should be compatible with these dose guidelines. For protective action guidelines on the order of 25, 50, or 100 rad, a dosimeter with relatively low sensitivity and precision might be adequate.

To more precisely track responders' dose received during the early phase response as well as later phase recovery operations, laboratory-read dosimeters could be appropriate. Dosimetry providers may be accredited under the National Voluntary Laboratory Accreditation Program (NVLAP) which uses various categories of radiation energies and dose ranges that are applicable to radiation workers.

Dosimeter format requirements will depend on the responders and compatibility with their personal protective equipment. Another consideration is whether or not the device is intended to be carried routinely or to be issued only in case of an event, and the projected number of users.

Standards

American National Standards Institute (ANSI) N13.11 "Personnel Dosimetry Performance – Criteria for Testing" (2001).

ANSI N42.20 "Performance Criteria for Active Personnel Radiation Monitors" (2003).

Table 1. Dosimeter Characteristics

Dosimeter Type	Read out Method	Dose	Format	Relative Unit Cost	Use
Pocket Ion Chamber	visual; analog scale	low* or high	cylinder	low	tactical
Radio-chromic	visual; color match	high	card	low	tactical
TLD / OSL	laboratory only	low* - high	badge card	low	dose of record
Electronic	visual; numeric (audible alarm)	low* - high	badge pager	high	tactical

*In this table "low" dose refers to doses less than about 5 rad.