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 Support Office.

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NUSTL

Radiation Mitigation Blankets

Following a terrorist incident or accident involving radiation, first responders and civilians should minimize their exposure to ionizing radiation. This can be accomplished by following the three basic radiation safety principles: minimize the time spent in the high-radiation environment, maintain maximum distance from the source of radiation, and use shielding to reduce exposure. First responders entering a radiation area should be equipped with monitoring equipment to pinpoint hotspots. Temporary shielding of these high-activity areas through the use of radiation mitigation blankets can help responders avoid contamination and reduce exposure. Appropriate respiratory protection should be worn by first responders, as these blankets are not effective in protecting against inhalation of airborne radioactive material.

How They Work

Radiation mitigation blankets act as a physical barrier that reduces or eliminates the passage of radiation. The various types of radiation differ in their ability to penetrate and damage matter through the ionization of atoms (Figure 1). Alpha particles are positively charged helium nuclei that are completely stopped by a few inches of air or a piece of paper. Beta particles are high-speed electrons of varying energy. They produce less ionization in matter than alpha particles but are more penetrating. Low energy betas can be stopped by a layer of clothing while higher energy betas cannot penetrate an inch of plastic.

Gamma rays are electromagnetic radiations (photons) and are very penetrating. Shielding or attenuation of gamma radiation occurs through the interaction of gamma photons with atoms in the shielding material. The degree to which gamma radiation is attenuated depends upon the energy of the incident radiation, and the atomic number, density, and thickness of the shielding material. The higher the energy of the gamma rays, the thicker the shielding required. Shielding efficiency increases with the atomic number and density of the shielding material. For example, a ¾-inch lead wool blanket with a density of 20 pounds per square foot can attenuate 30 percent of the 1,173 and 1,332 kiloelectronvolt gamma rays emitted by cobalt-60. Shielding effectiveness improves as the angle the radiation makes with the blanket decreases, since there is more material for the radiation to traverse at shallower angles.

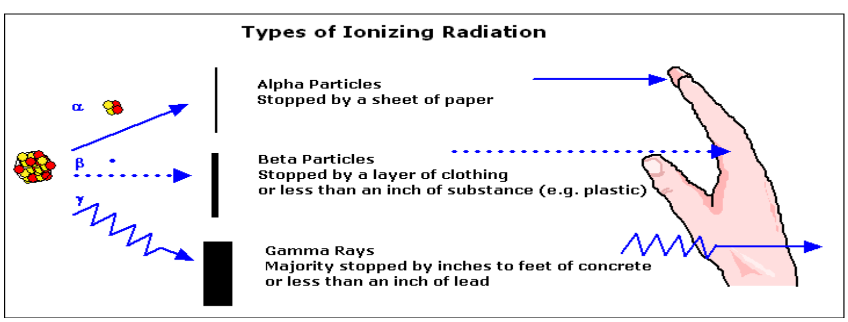

Figure 1. Penetration of Ionizing Radiation
(*Figure courtesy of the Health Physics Society*)

Types of Shielding Material

Lead is one of the most commonly used elements for shielding. It is very dense, has a high atomic number, is flexible, and is readily available. Lead blankets can be constructed with lead wool or lead plate, but lead wool is preferred because of its flexibility. Lead wool consists of fine strands of lead from 0.005 to 0.015 inch in diameter. The interlaced wool is compacted in a random orientation and sewn in a quilted pattern to prevent shifting. The lead is encapsulated with an inner and an outer cover for added protection and durability. Materials used for the covers can be plastic-laminated nylon or silicon-impregnated fiberglass fabric for withstanding high temperatures. Brass grommets are spaced as needed by most manufacturers (Figure 2).

Figure 2. Lead Wool Blanket with Grommets
(Photo courtesy of MarShield™)

Other materials with good shielding capabilities, such as tungsten, bismuth, and stainless steel, are also used to make radiation mitigation blankets. Tungsten, which has a higher density than lead, is an effective alternative and is being used more frequently due to its compatibility with other metals, non-toxicity, and pliability. However, its initial cost is about three times that of lead. Tungsten-impregnated silicone blankets and radiation protection vests were used in Japan after the Fukushima nuclear power plant accident.

Composite materials are also used because of their chemical resistance, physical durability, and portability. One manufacturer uses a polyethylene and PVC-based polymer containing very small dispersed metallic particles trapped between two layers of woven fabric. This material can also be made into a radiation protection suit worn by first responders (Figure 3). The manufacturer claims it is pliable, resistant to corrosive chemicals, and permits heat dissipation, which allows the wearer to stay cool. Other manufacturers use silicone and proprietary mixtures of radiation shielding materials to manufacture blankets with shielding properties comparable to lead.

Figure 3. First Responder with Radiation Protection
(Photo courtesy of Radiation Shield Technologies)

Applications

Radiation mitigation blankets can be used both by first responders aiding civilians following an accidental or intentional release of radiation, or by nuclear plant workers after an accident. Small areas of very high activity can be quickly shielded while people are being treated and emergency repairs are being made. Medical personnel treating victims with high levels of internal contamination can drape the blankets over the patients during transport and treatment. Radioactive material imbedded in a wound may require shielding to protect medical personnel from harmful exposures. Dose equivalent rates may be as high as 100 rem per hour (1 sievert per hour) close to a contaminated wound.

Considerations

Attenuation is frequently described in terms of lead sheet equivalent thickness. This allows one to compare the shielding capabilities of different materials and determine if a certain blanket will provide the level of protection needed. When more shielding is required, multiple blankets can be stacked to achieve a reduction in dose rate. Non-lead shielding materials have the advantage of being non-toxic and easily disposed of. If there is any radioactive contamination of a lead-containing blanket, it must be disposed of as mixed hazardous waste, which is difficult and expensive.

References

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