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

Structural Firefighting Gloves

Firefighters use different types of hand protection for different missions. For example, work gloves provide puncture protection during maintenance tasks, but they are not appropriate for firefighting. Extrication or rescue gloves provide protection from cuts, punctures, bodily fluids, and chemicals while still allowing the dexterity to operate rescue tools during vehicle extrications. Proximity gloves have a metallic outer layer for use in the extreme heat environments of aircraft and some chemical fires. Structural gloves, with resistance to flame, conductive heat, liquid penetration, cuts, and punctures are designed for use in fighting fires of residential and commercial structures.

Materials Used in Structural Firefighting Gloves

Structural firefighting gloves consist of an outer shell, a moisture barrier, and a thermal barrier, which may be configured as joined or continuous layers. Manufacturers use various materials for the layers. In many products, the outer shell is made of leather. Leathers provide friction grip and puncture resistance, and can be specially processed for flame resistance during tanning. Full grain cowhide, pig, elk, and goat skin are commonly used, or kangaroo skin, which can be made thinner. Some products use leathers impregnated with silicone to improve water repellence and durability. Other products use synthetic fiber materials, such as Kevlar™ or Nomex™, instead of leather for their high strength to weight properties. These materials may be combined with additional reinforcements added to the outside palm or back of the hand, or to internal layers. Some gloves combine several materials.

Leather Structural Firefighting Glove

The moisture barrier prevents penetration of liquids such as water, blood, and some chemicals. Polytetrafluoroethylene (PTFE, e.g. Teflon™) is commonly used because it repels water and is heat resistant. In some products, the moisture and thermal barriers are combined into one material. In others, the thermal barrier is an inner lining that insulates the hand from heat and provides a layer of comfort. A synthetic polymer knit material known as a modacrylic is often used for the glove thermal lining because it is flame resistant and a good insulator. Kevlar or Nomex may also be used for the thermal barrier. All thread used in the glove construction must be inherently flame resistant fiber, and any metal hardware must be resistant to corrosion.

Glove Construction

Details of the glove construction are important factors in comfort and functionality. The main part of a structural firefighting glove is called the glove body; it encases the fingers and palm and extends at least 2 inches beyond the wrist crease. Some gloves may also extend beyond 2 inches from the wrist crease. Material from 2 to 5 inches beyond the wrist crease is called the

glove interface component. It may be wristlet style, in which a knit material fits snugly around the wrist, or a more loose-fitting gauntlet style. Some products offer a convertible cuff that can function as wristlet or gauntlet style. Any material beyond 5 inches from the wrist crease is called the glove extension.

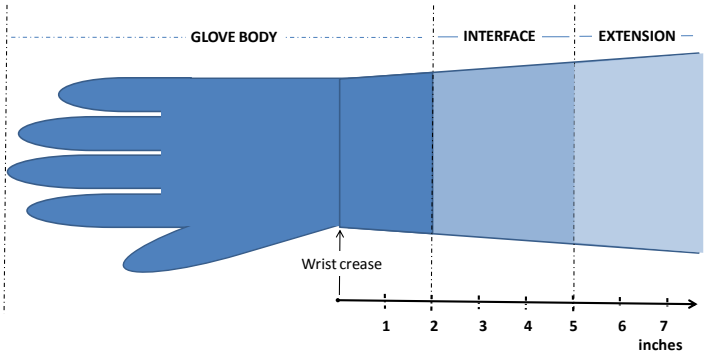

Illustration of Glove Sections. The distance from fingers to wrist crease is specified for standard sizing dimensions.

The geometric design of the glove body, such as the way the fingers and thumb protrude, varies from one product to another. For example, a two-dimensional glove design consists of two sheets of material joined by a continuous seam along the outline of the hand between each finger. In contrast, a three-dimensional design uses an additional inset of glove material to form a sidewall on the side of each finger between the two sheets. A "roll-over" design extends the fabric from the palm side over the top of the finger to the fingernail area to create a seamless fingertip. Some products enhance the three-dimensional design with a curved shape to the fingers to conform to the natural hand shape. A separate piece of material used for the thumb can allow it to protrude in opposition to the fingers, from the palm rather than the edge of the hand.

Considerations

In selecting an appropriate structural glove, a number of considerations often involve trade-offs between features.

Dexterity

Dexterity encompasses finger and palm grip, finger flexibility, and fingertip tactility. Some design elements, such as the location of seams or adhesives at the fingertips or bunching of material in the palms, can reduce dexterity. Other design features can enhance dexterity, such as seamless fingertips and added texture to increase grip friction. However, the composite layers of materials needed to protect the hand tend to add stiffness and bulk, resulting in a trade-off between hand protection and dexterity. Having to remove gloves to perform certain tasks, such as changing radio frequency or putting on breathing apparatus, would undermine a firefighter's overall safety.

Donning and Doffing

Donning and doffing refers to the ability to easily put on and take off wet or dry gloves. Gloves with textured linings that increase grip can be harder to put on. The style of the interface component may also affect the ease of donning and doffing gloves. Wider gauntlets and palm openings may make it easier to don and doff but may reduce protection or grip.

Fit

Proper fit is critical to obtain adequate protection and hand function. Structural gloves are available in multiple sizes and may also be custom fitted to an individual. A tighter fit may provide better dexterity, but compression of the glove layers can impact thermal protection.

Cost

The cost of structural gloves may also influence selection. Advanced or exotic materials and complex construction may provide state of the art hand protection at the trade-off of expense. Durability also factors into the overall cost, as gloves are subject to demanding tasks.

Standards

The National Fire Protection Association (NFPA), an international nonprofit organization that provides standards for fire safety, published NFPA 1971: *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting* (2013). It is available for purchase or viewing in a free, read-only format at the NFPA website at http://www.nfpa.org/codes-and-standards/free-access. This key standard contains performance requirements for structural firefighting gloves, including flame and conductive heat resistance, liquid penetration, cut/puncture resistance, hand function, and grip. For a product to be labeled as certified compliant with NFPA 1971, it must be tested by an independent third party certification organization as specified in NFPA 1971.

Thermal Protective Performance (TPP) is an estimate of the thermal insulation of the composite material. To comply with NFPA 1971, the structural firefighting glove body must have a TPP of at least 35.0, a second-degree burn time of not less than 10.0 seconds, and a pain time of not less than 6.0 seconds. The glove interface component has lower requirements; for example, a minimum TPP of 20.0.

NFPA 1971 requires gloves to be available in seven different sizes (XXS to XXL), and provides the dimensions for the circumference and length for the hand and for each finger. It describes tests for dry hand donning and wet hand donning, which must be achievable within 10 seconds and 30 seconds, respectively, with no detachment of the inner layer or moisture barrier.

The Federal Emergency Management Agency (FEMA), U.S. Fire Administration published *Minimum Standards on Structural Fire Fighting Protective Clothing and Equipment: A Guide for Fire Service Education and Procurement* (1992). It is available at the FEMA website at http://www.usfa.fema.gov/downloads/pdf/publications/fa-137.pdf.