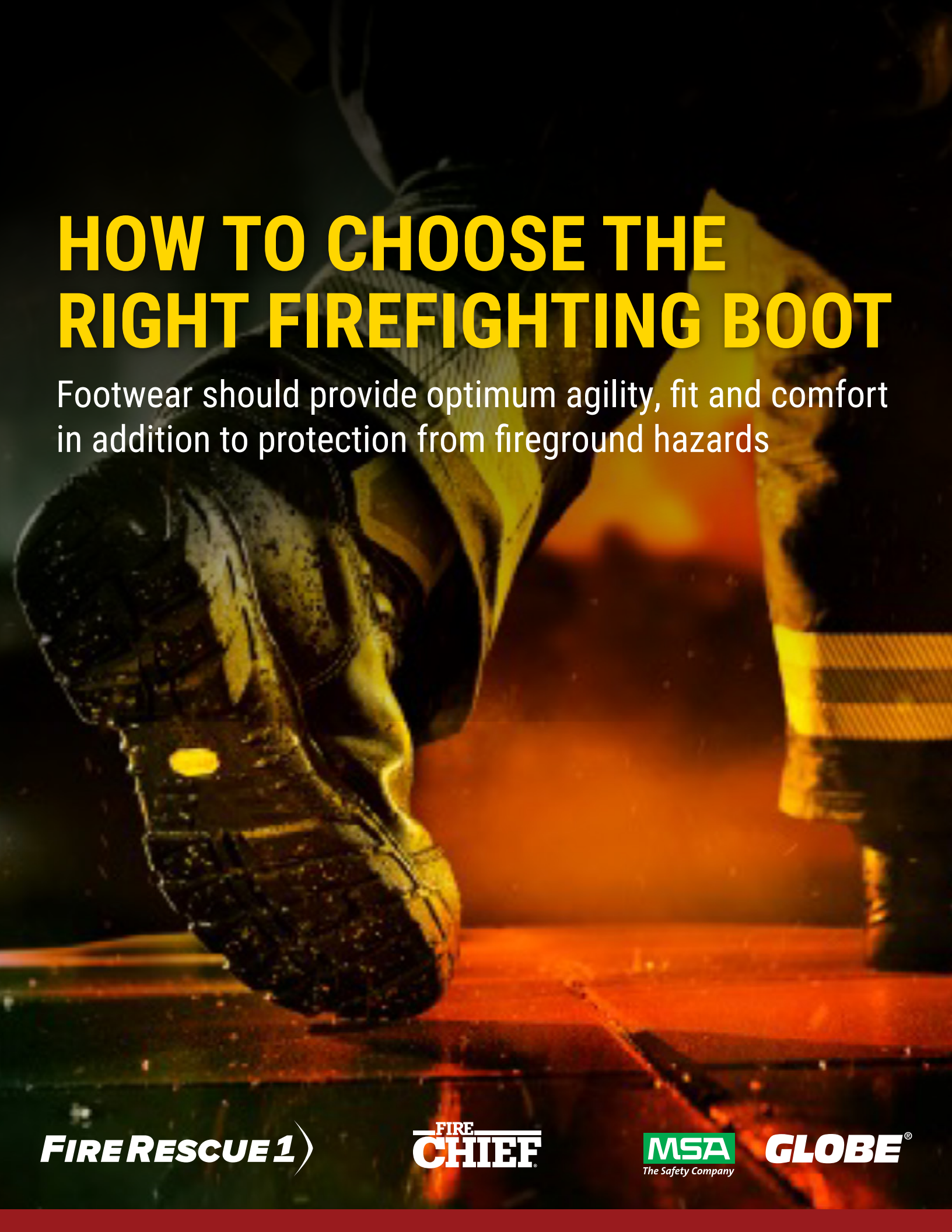

HOW TO CHOOSE THE RIGHT FIREFIGHTING BOOT

Footwear should provide optimum agility, fit and comfort in addition to protection from fireground hazards

FIRE RESCUE 1 | FIRE CHIEF | MSA The Safety Company | GLOBE®

EDITOR'S NOTE

Firefighting boots need to do much more than keep your feet dry. They have to shield your feet from hazards, as well as allow sufficient comfort and dexterity to perform physically demanding work. These goals can be at cross purposes – a challenge not lost on scientists, engineers or firefighters.

Whether you are on a purchasing committee or just out to buy a better boot, your safety may depend on what's on your feet. This guide to choosing firefighter boots:

- Gives you a look into research and development over the past decade to improve both protection and functionality.
- Provides tips on how to apply that information to your next boot selection.

Good luck and stay safe,

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BALANCING FOOTWEAR FUNCTION WITH PROTECTION

Firefighters today have a multitude of choices for footwear that conforms to NFPA 1971: Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting, 2018 edition. But not all footwear offers the same level of functional use or protection, and each individual firefighter will have different preferences.

Functional footwear performance is a legitimate concern for firefighters. Footwear must not only help protect against different fireground hazards, it must also permit firefighters to perform their jobs with optimum levels of agility and comfort.

Footwear that does not fit well or is not comfortable can create problems. This is one of the reasons why NFPA outlines specifications for a diverse range of sizes, in both male and female patterns, among other requirements. Nevertheless, as with any footwear, various firefighter products fit individual firefighters differently. Read on to learn more about fit and other factors to consider when buying firefighting boots.

WHAT RESEARCH SAYS ABOUT THE FACTORS THAT DRIVE FIREFIGHTER BOOT CHOICES

Firefighters must consider a variety of factors when choosing boots. These include but are not limited to overall weight, comfort and fit, protective performance, durability and cost. As with the selection of any firefighter footwear, the determination of the most important characteristics often involves a series of tradeoffs, without compromising safety.

In 2012, NIOSH conducted a study on the effects different boot constructions have on firefighter movement and energy expenditure.[1] In the study, 14 male and 13 female firefighters were provided with one of four different boot types. Phase I of the study concentrated on wearing rubber boots as compared to wearing leather boots, while Phase II compared cement-soled footwear versus stitched-soled footwear. While wearing full turnout gear, the subjects were instructed to walk for five minutes, stepping over obstacles as part of the activity. During this exercise, researchers took measurements of characteristics such as the participants' gait, heart rate and oxygen consumption.

WEIGHT

The study determined that boot weight is a key factor. Heavy footwear puts a strain on the wearer, potentially leading to earlier fatigue and affecting the wearer's gait. One finding of the NIOSH study was that lighter boots can reduce the potential for injury. In general, leather boots are about 2.5 pounds lighter than rubber boots.

It was also noted that heavier boots significantly reduced how high the firefighters were able to raise their second, or trailing, leg to clear obstacles. All tripping incidents that occurred during the study were caused by the trailing foot, regardless of the type of boot.

A subsequent study that tested firefighters on a treadmill also showed as much as a 10 percent increase in oxygen consumption per kilogram of boot weight.[2] Other research has indicated that a 1-pound reduction in footwear is equivalent to taking 5 pounds of weight off the firefighter's back.

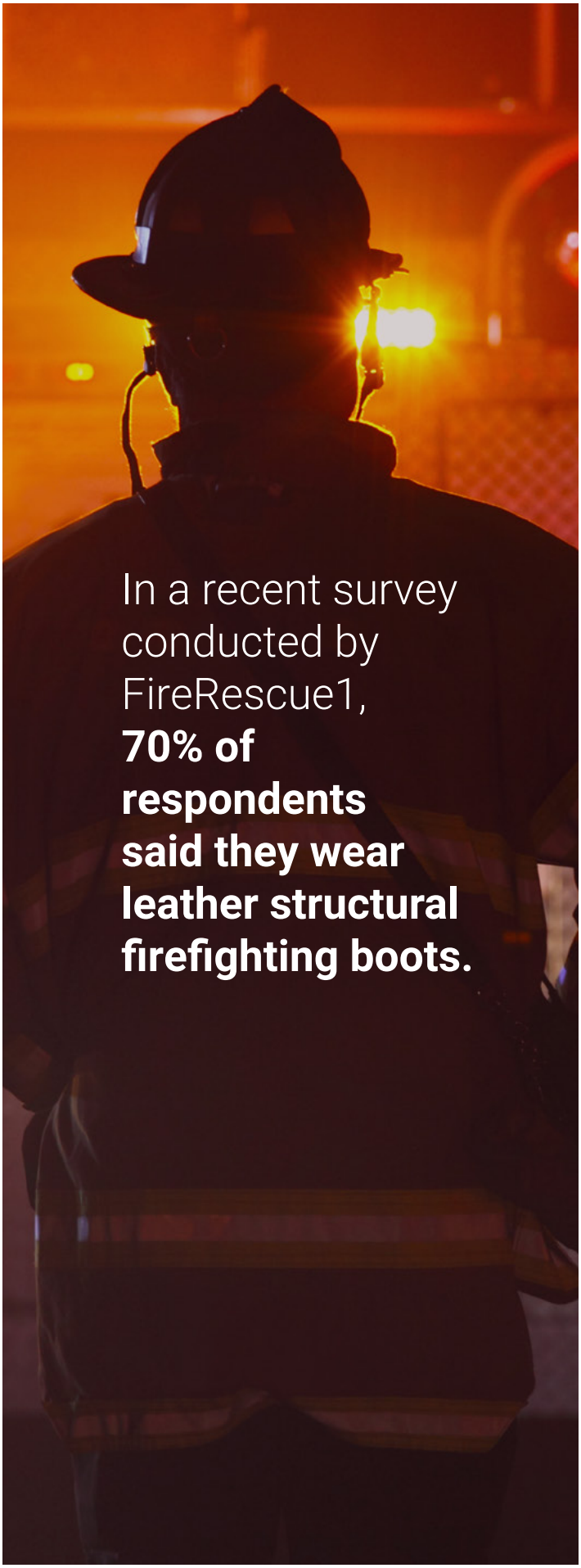
In short, heavier boots cause firefighters to exert more energy and are more likely to contribute to tripping and injuries. But the specification of weight alone cannot address these issues, as several other factors can affect footwear-imposed stress and firefighter agility, such as the flexibility of the component materials, the actual footwear height, traction from the outer sole and tread design – as well as individual firefighter coordination.

FLEXIBILITY & COMFORT

Footwear must not only help protect against hazards, it must also allow for appropriate levels of agility and comfort. Comfort promotes safety by allowing firefighters to focus on the task at hand, not their feet. You don't want to be in a situation where you need to concentrate on the scene but are distracted by sore feet or blisters.

Flexibility promotes comfort, which in turn helps reduce physical stress. In the NIOSH study, the more flexible the boot's sole, the less oxygen the firefighter consumed because the test exercise was less strenuous. In fact, the firefighters' metabolic rates were reduced by as much as 7% when they wore boots with more flexible soles. This is not to say that other construction methods will not also contribute to comfort and flexibility; it is just one example of why choosing the right footwear is so important.

Firefighters in cold climates need to be sure to consider traction when it comes to snow and ice. While no footwear can eliminate all slips and falls, look for flexible, slip-resistant soles designed to provide traction on wet ice to help reduce the potential for injuries. The more flexible the boot soles remain in colder weather, the less physiological strain and thus less likelihood of trips and falls on the fireground.



In a recent survey conducted by FireRescue1, **70% of respondents said they wear leather structural firefighting boots.**

RUBBER VS. LEATHER

Many departments have used rubber boots since the 1930s. The thinking held that rubber boots are waterproof, durable and easy to pull on – not to mention cheaper. However, while it is true that leather boots can cost twice as much as rubber boots, they weigh less, are significantly more flexible and generally are considered to provide added support for the wearer.

Some firefighters believe that rubber boots are easier to clean/decontaminate, but a study by W.L. Gore proved the opposite. The cellular structure of rubber actually traps hazardous materials, whereas the Gore study concluded that leather sheds most chemicals when hosed off.

One further consideration for leather boots is that they are more stable and slip-resistant, especially for firefighters with ankle issues. A study by Auburn University and the University of Mississippi found that firefighters were four times more likely to have a hazardous slip when wearing rubber boots as compared to leather boots.

FINDING THE RIGHT FIT

A good fit is essential not only for flexibility, but also because footwear that fits properly assists in providing protection without compromising comfort.

Another important aspect in the overall fit of footwear is ankle support. Good ankle support helps to alleviate potential injuries caused by stepping on uneven or sloping surfaces – activities that can lead to strains and sprains, which are responsible for the highest proportion of all firefighter lost-time injuries. Different footwear types provide different degrees of ankle support based on the inherent design of the footwear and its ability to properly fit the firefighter.

Wear trials are the best way to determine how well boots provide adequate movement and support. Such tests involve a limited number of firefighters who are properly fitted in the respective footwear and put the boots through a series of fireground exercises in order to subjectively assess the performance. When conducting a wear test, it is important that each wear test subject have the opportunity to wear each different footwear product under consideration.

No amount of research can replace direct assessments under actual conditions. Fire departments and firefighters should judge for themselves which products provide the right combination of performance and functional use.

STEEL OR COMPOSITE TOE CAP?

Many protective footwear manufacturers have begun using composite materials, in the heel counter, shank, toe cap or other area simply because the strength of the composite material is comparable to steel, but at a considerable reduction in weight.

Footwear manufactured with composite materials still meet and often exceed the minimum requirements for NFPA but may be up to 30% lighter than steel-toed boots.

Also, composite materials do not conduct cold like steel, so more heat is kept within the boot during winter months when the weather is colder.

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WHAT BOOT ATTRIBUTES ARE MOST IMPORTANT TO YOU?

It is important to identify your needs and decide which characteristics are most important. An easy way to help with this is to rank the following attributes from 1 to 10 and use the results to evaluate boots you may be considering.

- **Lighter Weight**
- **More Durable**
- **More Thermal Protection**
- **More Breathable**
- **More Flexible**
- **More Innovative Design**
- **Better Slip Resistance**
- **Better Overall Fit and Feel**
- **Best Value for the Price**

BOOTS THAT COMPLY:
WHAT FIREFIGHTERS SHOULD KNOW BEFORE PURCHASING BOOTS

Long hours on the job, miles logged on hard floors and exposure to a multitude of physical hazards can really take their toll on your feet. Selecting the proper footwear and properly caring for it will help make for happy feet. Before you buy your next pair of boots, read up on the available products and different features – your feet will thank you.

Above all, your boots need to meet the requirements of the standards applicable to firefighting footwear. Be sure that the footwear under consideration is labeled as meeting the appropriate NFPA standard that best supports your intended use.

OSHA Regulation 1910.136 states that employers must provide protective footwear for employees who work in areas where there is a danger of foot injuries due to falling, rolling or piercing objects and in areas where their feet are exposed to electrical hazards. Boots that are labeled to NFPA 1971 meet and exceed this OSHA requirement.

Whole footwear must be tested for heat resistance, flame resistance, abrasion resistance, overall liquid integrity and electrical insulation, as well as for viral penetration resistance from leakage of blood and body fluids. Slip resistance (traction) is also tested.

Here are detailed lists of what the NFPA standard requires for design and performance of structural firefighting footwear:

NFPA 1971 Design Requirements for Structural Firefighter Footwear

- A sole with a heel.
- An upper with a lining.
- An insole.
- A puncture resistant device.
- A ladder shank or whole sole equivalent.
- An impact- and compression-resistant toe cap.
- Footwear must be stitched with inherently flame-resistant thread.
- Footwear must be at least 250mm (9.84 inches) high as measured on the inside from the center of the insole at the heel upward to a reference line extending across the footwear at the lowest point of the top line, excluding the tongue and gusset.
- Continuous thermal, physical and moisture protection to within 50mm (2 inches) of the top of the footwear at all locations excepting 13mm (1/2 inch) around penetrating pull-up holes.
- A heel breast not less than 13mm (1/2 inch) or more than 25mm (1/2 inch) and a heel breasting angle of not less than 90 degrees or more than 135 degrees.
- A heel that is as wide or wider than the width of the sole at the intersection of the heel breast and sole bottom.
- Hardware and external fittings:
    - Must be free of rough spots.
    - No metal parts can penetrate from the outside of the footwear into the lining or insole at any point.
    - No metal parts can be used in the construction or attachment of the sole with the heel to the puncture-resistant device, to the insole or to the upper.
- The puncture-resistant device must cover the maximum area of the insole in accordance with Section 3.3 of CSA Z195, Protective Footwear.
- Manufacturers must make available an extensive set of footwear sizing with unique sizes for men and women, including half sizes and a minimum of three widths over the range of sizes 5 to 16 for men and sizes 5 to 10 for women.
    - Full and half sizes for both men and women must be accomplished by individual and unique men's and women's lasts.
    - Dual sizing of the same pair of boots to cover male and female footwear sizing is not acceptable.
- Footwear must meet the performance requirements specified in ASTM F 2413 for impact, compression and puncture resistance, with the more stringent exception that flex resistance to cracking is evaluated at 1 million cycles in the NFPA standard.

NFPA 1971 Performance Requirements for Structural Firefighter Footwear

- All sewing thread used in construction must not melt at temperatures below 260°C (500°F).
- Eyelet/stud post attachments must resist detachment up to 294N (66 pounds of force).
- Soles and heels must provide abrasion resistance, with relative volume loss no greater than 250mm.
- Labels are tested for durability and legibility and must remain in place following testing.
- Ladder shanks or whole sole equivalents must not bend more than 6mm (1/4 inch).
- Slip Resistance: Footwear shall have coefficient of friction of 0.40 or greater, which indicates the ability of the footwear to resist slipping under specified test conditions.

- Flame Resistance: In a whole-boot flame test, the boot must not melt or drip, nor exhibit any burn-through, and any after-flame must be less than 5.0 seconds.
- Heat and Thermal Resistance: No melting, separating, ignition or water penetration is permitted, and all components must remain functional.
- Thermal Insulation:
  - Radiant Heat Resistance: Upper surface in contact with skin must not exceed 44°C (111°F).
  - Conductive Heat Resistance:
    - Insole surface in contact with feet must not exceed 44°C (111°F).
    - Footwear must protect the wearer against pain from heat for a minimum of 6 seconds and against second degree burn for a minimum of 10 seconds.
- Liquid Penetration: Upper material and seams must prevent liquid penetration for at least 1 hour.
- Viral Penetration: Upper material and seams must prevent bacteriophage penetration for at least 1 hour.
- Cut Resistance: Uppers must have a cut resistance distance of more than 20mm (0.8 inch).
- Puncture Resistance: Uppers must resist puncture under applied force of 60N (13 pounds).
- Electrical Insulation: No current leakage in excess of 3.0 milliamp (3/1,000 of an ampere).
- Corrosion Resistance:
  - All metals: Must show no more than light surface corrosion or oxidation.
  - Ferrous metals: No corrosion of base metal.
  - All hardware must remain functional.

RESOURCES

Footwear on FireRescue1

PPE101

NFPA 1971: Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

STUDY: Effect of Boot Weight and Sole Flexibility on Gait and Physiological Responses of Firefighters in Stepping Over Obstacles

VIDEO: Broomball on Ice