



HOW TO CHOOSE THE RIGHT FIREFIGHTING BOOT

Guidelines to select a structural firefighting boot that fits, performs and lasts

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How to Select the Safest Structural Firefighting Boots

For many of us, our first set of fire boots were the clunky, ill-fitting rubber boots handed to us when we were accepted on the fire department. And if you got those, you quickly gained an appreciation that more goes into firefighting boots than your feet.

Firefighting boots need to do much more than keep your feet dry. They have to shield your feet and legs from hazards and allow the comfort and dexterity to perform physically demanding work. Those dual goals can be at cross-purposes — it's a challenge not lost on scientists, engineers or firefighters.

This short firefighter boot guide gives you a look into what is going on to improve both protection and functionality in firefighter footwear. It takes you through what's been learned from recent studies and how to apply that information to your next boot selection. Because whether you are now on a purchasing committee or just out to buy a better boot, your safety may depend on what's on your feet.

— Rick Markley, Editor-in-Chief

Science Drives Firefighter Boots Choices

Trying to save money on firefighting boots can come at the expense of safety, and there's research to back that

By FireRescue1 Staff

In a relatively short time, the firefighting boot has evolved from an almost afterthought to a highly specialized piece of protective gear. Each new generation of structural firefighting boot looks less and less like the fishing waders of days gone by and more like a purpose-built piece of equipment.

Part of that evolution has been a shift in boot materials and construction. In a 2012 informal poll, FireRescue1 readers overwhelmingly prefer leather to rubber for their firefighting boots. Only 7 percent of respondents said rubber was their first choice. Breathability was also a major driver of leather boot purchases. Our readers cited the importance of breathability criteria, noting that the lack of breathability in rubber boots made them appreciate the breathability in leather boots.

Deputy Fire Marshal Jon Williams of Union County, N.C., is also a Captain at Unionville Volunteer Fire Department. "I have a lace-up/zip set at work as fire marshal and a traditional pull-on leather for my volunteer department," Williams said, citing the comfort as his defining criterion. "They wear like a tennis shoe," he said.

In that same year, NIOSH conducted a study on the effects different boot constructions have on firefighter movement and energy use. One finding was that leather boots are likely to reduce injury due to their lighter weight when compared with rubber boots. Leather boots are about 2 ½ pounds lighter than rubber boots.



The study randomly gave 14 male and 13 female firefighters one of four different boot types. Wearing full turnout gear, the subjects walked for five minutes, stepping over obstacles.

The findings

Researchers measured things like their gait, heart rate and oxygen consumption. What they found was that heavier boots significantly reduced how high the firefighters' second, or trailing, legs raised to clear the obstacles. All of the tripping incidents in the study were caused by the trailing foot — regardless of the type of boot.

In short, heavier boots are more likely to contribute to firefighters tripping. The heavier boots also caused firefighters to exert more energy during the test.

“The cellular structure of rubber actually traps hazardous materials, whereas leather sheds most chemicals when hosed off.”

A previous study that tested firefighters on a treadmill showed as much as a 10 percent increase in oxygen consumption per kilogram of boot weight.

Leather-boot construction comes down to cemented or stitched soles — cement construction being the more flexible of the two.

One of the recent study’s interesting findings was that the more flexible the boot’s sole, the less oxygen the firefighter consumed, meaning the walking and stepping exercise was less strenuous. They found that firefighters’ metabolic rates were reduced by as much as 7 percent when they wore boots with increased sole flexibility.

Rubber vs leather

Some of FireRescue1’s poll respondents said rubber boots were easier to pull on during quick-dress drills. Others liked that they were naturally waterproof, and still others said they were more durable than leather. They’re also a good deal cheaper. Leather boots can cost twice as much as rubber boots, according to boot manufacturers.

Some firefighters also said that rubber boots are easier to clean when involved in a hazmat situation. But a study by W.L. Gore proved the opposite. The cellular structure of rubber actually traps hazardous materials, it said, whereas leather sheds most chemicals when hosed off.

Rubber boots also come with a bit of tradition. Many departments have used rubber boots since the 1930s.

Firefighter Hunter Knight of the Moody Fire Department in Birmingham, Ala., said the firefighters with longer tenure in his department at first honored tradition by

sticking to rubber boots. But now they have mostly switched to leather.

Comfort factor

And what is the basis for this? Newer leather boots are more stable, providing similar support to rubber, Knight said, especially for firefighters with ankle issues.

A [recent 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 compared to leather boots.

Knight also cites leather’s superior comfort. “You don’t want to be somewhere where you’re supposed to concentrate on the scene but you’re focused on your feet hurting,” he said. “If you’re more comfortable, you’re more safe.”

As FireRescue1’s PPE columnists Jeff and Grace Stull outlined in a [previous article](#), the important aspect of choosing between rubber and leather footwear is to weigh your organization’s needs and decide which characteristics are more important — weight, comfort/fit, performance, durability, contamination resistance and cost.

“Some of these characteristics can be determined by understanding other departments’ experiences with specific styles of footwear and the relative service provided by the footwear,” they said.

“As with any type of personal protective equipment, it is difficult to achieve 100 percent satisfaction between all firefighters,” they said. “However, it is important that all firefighters be afforded proper fitting footwear that provides an acceptable level of protection without compromising their safety.”

Balancing Footwear Function with Protection

Footwear must not only protect against hazards, it must also allow for appropriate levels of agility and comfort

By Jeffrey O. and Grace G. Stull

There are many performance requirements applied to firefighter footwear in NFPA 1971, the standard that covers protective footwear for structural firefighting. Nevertheless, there are still aspects of footwear use that must be considered, not all of which are addressed in NFPA 1971.

Here's what is tested.

Whole footwear is tested for heat resistance, flame resistance, overall liquid integrity and electrical insulation.

Footwear seams are evaluated for liquid penetration resistance against fireground chemicals like battery acid, gasoline and hydraulic fluid and for viral penetration resistance — for leakage of blood and body fluids that may be contaminated with pathogenic organisms such as Hepatitis.

The upper portion of the footwear is tested for radiant heat resistance, conductive heat resistance, cut resistance and puncture resistance. The toe section is evaluated for impact and compression resistance. The soles are tested for puncture resistance, abrasion resistance, conductive heat resistance and slip resistance or traction. The puncture and heat-conduction tests are different than those applied to the footwear upper.

The shank — a metal or composite piece that provides stiffness between the front of the heel and the back of the forefoot in the sole — is tested for bending resistance.

The hardware is tested for corrosion resistance, and eyelets and stud hooks, if present, are tested for detachment strength. The thread is tested for melting temperature.

Finally, footwear labels are evaluated for legibility and durability.

Design requirements

There are also several design requirements for firefighter boots. Footwear must have a sole with a heel, an upper with a lining, an insole with a puncture-resistance device (a metal plate or composite layer set above the outer sole) and a permanently integrated impact and compression resistant toe cap, which may be metal or composite.

NFPA calls for the footwear to be at least 10 inches high as measured from the inside of the footwear with the insole in place to the highest point on the boot where there is continuous liquid protection. NFPA also specifies that a certain range of heel breast angle be used; this is the interior angle formed between the heel and the sole.

The standard says that no hardware can penetrate from the outside of the footwear to the lining, which would act as an avenue for heat conduction or liquid infiltration. The soles of the boots cannot be attached using nails or screws.

Lastly, NFPA 1971 requires that manufacturers 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 13 for men and sizes 5 to 10 for women. This sizing design requirement is the most extensive footwear requirement outside of the military for work-based footwear.

Range of options

Even with the design requirements, manufacturers have the latitude to pursue different designs and choices of materials. Conventionally, there are rubber and leather boots. Some boots combine different materials such as leather and durable fabrics.

There are a number of different lining materials, barrier materials, closure options and methods of construction.

All of these attributes provide a multitude of choices for footwear that conform to the NFPA 1971 standard. But this does not mean that all types of footwear protect firefighters to the same level or even offer the same levels of functional use.

Further, there are different preferences for footwear by individual firefighters with some aspects of NFPA 1971-based performance being addressed well, some not so well and others not at all.

Generally, there are no complaints about the levels of insulation provided by footwear, which in turn are affected by the tests in the standard that set minimum protection requirements. While slip resistance is part of NFPA 1971, there are concerns that the test and criteria do not do what they are supposed to do — ensure appropriate levels of traction on slick surfaces.

Consequently, some work is ongoing by the responsible committee to identify a more suitable test that better ranks footwear for its traction consistent with field observations. As an example of footwear attributes where there are no requirements, nothing in the current standard addresses the functional performance of footwear as is done for gloves (such as dexterity and grip testing).



“Good ankle support helps to alleviate potential injuries caused by stepping on uneven or sloping surfaces, activities that can lead to strains and sprains, the highest proportion of all firefighter lost-time injuries.”

Footwear performance

Functional footwear performance is a legitimate concern for firefighters. Footwear must not only protect well against different fireground hazards, but it must permit firefighters to be active with appropriate levels of agility and comfort.

Footwear that does not fit well or is not comfortable will create problems. It goes without saying that footwear should not chafe firefighters’ feet or legs and should not cause blisters. This is one of the reasons why NFPA dictates a diverse range of sizes be provided. But like regular shoes, various firefighter footwear products fit individual firefighters differently.

An important aspect in the 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, 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. Yet, prescribing ankle support is not easily done.

Boot weight is another factor. As expected, heavier footwear will put a strain on the wearer, potentially leading to earlier fatigue and changing the firefighters’ gait as some recent studies have shown.

Still, the specification of weight alone cannot address this issue as there are several factors that can affect footwear-imposed stress and firefighter agility. For example, the flexibility of the materials, the actual footwear height, traction as imparted by the outer sole

and tread design and individual firefighter coordination can all have a bearing on this aspect of performance.

Finding the right fit

Unfortunately, there is no standardized laboratory test that can assess how well firefighter footwear fits and provides ankle support. Different manufacturers have attempted to create evaluation protocols that measure how easily firefighters can move in the footwear without undue impediments.

Many of these protocols involve visually assessing firefighter movement while wearing the footwear in different types of obstacle courses. Other testing entails measuring how much energy firefighters expend physiologically.

However, in all cases, the footwear is part of an overall ensemble where the entire system has an effect on firefighter movement or energy consumption.

Wear trials

Practically, the best way for determining how well boots provide adequate movement and support are through wear trials. These would involve a limited number of firefighters who are properly fit in the respective footwear and put the boots through a series of fireground exercises in order to subjectively assess the performance.

No test 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.

Additional Resources

- [Effect of Boot Weight and Sole Flexibility on Gait and Physiological Responses of Firefighters in Stepping Over Obstacles](#)
- [Decontamination Effectiveness of Leather and Rubber Samples Specifically Treated for Fire Boot Applications](#)
- [Improving Stability with Leather Boots](#)
- [NFPA 1971](#)
- [PPE101](#)

What Boot Attributes are Most Important to You?

Rank the following 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
- Better Fit
- More Innovative Design
- Better Slip Resistance
- Warmer in Cold Weather
- Lower Price

