Fire Tech Tips

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Changes for Firefighter Shirts and Pants

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Since the early 1960s, the U.S. Department of Agriculture, Forest Service specification for shirts worn by wildland firefighters has gone through several revisions. The familiar yellow wildland firefighter shirt will soon have a new look. The new-style shirt has an updated design and will be made with a new fabric. The shirt fabric has remained unchanged since 1992, when the current "Breezetone" fabric, made of 93 percent meta-aramid, 5 percent para-aramid, and 2 percent carbon fibers (Nomex IIIA), was adopted as the firefighter standard by the Forest Service.

2006 Evaluation Responses

In the summer of 2006, the Missoula Technology and Development Center (MTDC) distributed a questionnaire to determine firefighter satisfaction with the current flame-resistant (FR) shirts made to Forest Service specification 5100-91. FIrefighters returned more than 1,500 questionnaires from 41 States. The firefighter responses provided data on the shirt's fit, comfort, utility, and durability. Analysis of the responses led to a redesign process aimed at improving the shirt's fit and comfort without losing any usefulness, durability, or protection. MTDC's involvement in accident investigations and reviews also provides insight into personal protective equipment (PPE) designs.

For wear testing in 2008 and 2009, MTDC sent nearly 300 prototype shirts to firefighters on crews throughout the United States. The following information comparing firefighter satisfaction with the current shirt and the prototype shirt is based on firefighter input gathered by the 2006 questionnaire and 204 field evaluations.

Highlights...

- More than 1,500 firefighters responded to the Missoula Technology and Development Center 2006 nationwide product review of flame-resistant firefighter shirts.
- By changing the shirt design and fabric, firefighters gain a looser fit and more protection from radiant heat; by changing the pants fabric and color, firefighters have a comfortable, lighter weight option.
- Both styles (old and new) of pants and shirts are acceptable for fire use.

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Shirt Design Changes

FIrefighters identified two areas for improvement: fit through the shoulders and sleeve length. MTDC addresssed these needs by incorporating "bi-swing bellows" into the back and by using a two-piece arm that creates an articulated sleeve. These pattern changes produced a garment with a looser fit through the back, shoulders, chest, and arms while not significantly changing either the chest or sleeve length measurements (figure 1).

Firefighters also will find a better sleeve length fit; the sleeve cuff will now stay at the wrist location when arms are extended and will not slide up the forearms of the firefighter. This looser fit is preferable to a tighter fit for three reasons: offers more radiant heat protection, promotes better ventilation that increases cooling since more air can circulate through the garment, and broadens the range of each size to fit more firefighters.

Figure 1—The new shirt's design includes a different collar with Velcro closure and a "bi-swing bellows" back.

Because of the looser fit, firefighters may want to wear the next smaller size than they currently wear.

In addition to the looser fit, the new shirt design includes three other notable changes:

- A redesigned collar with a Velcro tab that provides a more positive closure at the neck for aviation and chain saw operations
- The addition of a pen and pencil pocket to the upper left sleeve for easy access
- Elbow patches added for extra protection from heat in the most vulnerable area

Shirt Fabric Change

The 2006 questionnaire also indicated that firefighters considered the current "Breezetone" fabric inadequate in three measures of user comfort; it was rated as too warm, too thick, and too stiff. Many FR fabrics were considered for wear testing. Every fabric under consideration met the requirements of the National Fire Protection Association (NFPA) 1977 Standard on Protective Clothing and Equipment for Wildland Fire Fighting. This ensures the fabrics met the NFPA requirement for thermal protection as well as total heat loss (THL) and strength. To find a fabric more satisfactory to firefighters, MTDC selected eight fabrics and tested them for 2 years. The eight fabrics from five different manufacturers included a modacrylic blend, an FR rayon blend, a polybenzimidazole (Pbi) blend, and various meta-aramid blends. The fabrics also varied in weight and weave types.

MTDC selected a new material for the firefighter shirt as a result of wear testing. The fabric selected is actually made from the same blend of fibers as the previous fabric—93 percent meta-aramid, 5 percent para-aramid, and 2 percent carbon fibers. The differences are found in the weave and the weight. The new fabric is a plain weave rather than the modified basket weave of the "Breezetone" fabric. The weight difference is very slight, changing to a weight of 5.5 ounces (per square yard) instead of the current 5.8. These changes, while not dramatic, produced a fabric that the wear testers rated more favorably than the "Breezetone" on all measurements (figure 2).

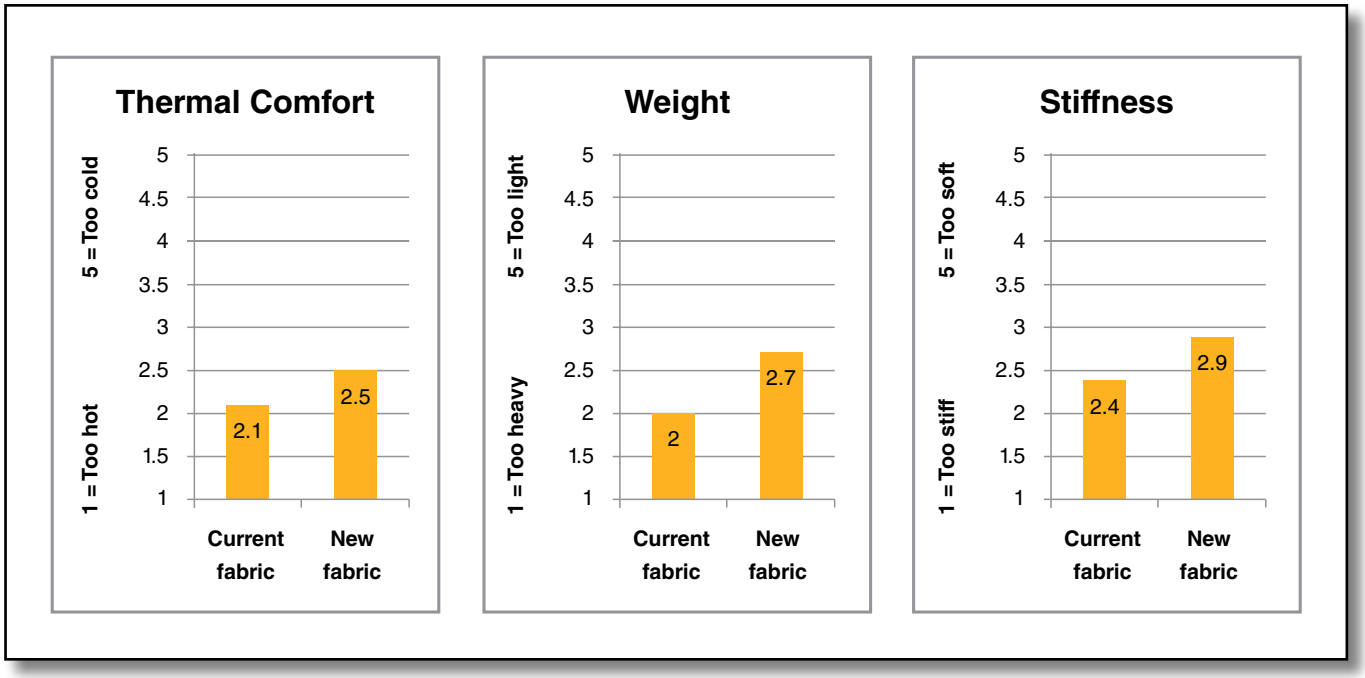

Figure 2—Based on these three measures (thermal comfort, weight, and stiffness), the new fabric was rated higher than the current fabric. In the averaged responses received from wear test participants, a score of 3 equates to a rating of "just right."

The durability of the new fabric also was rated satisfactorily by the wear testers with very few reported weaknesses, such as fabric pilling, tearing, thinning, or fading. The expected life span of the new shirts should be comparable to the current product since the basic fabric is only minimally changed.

> Great Shirt!! Felt the breathability of the shirt was very helpful.
>
> *—Wear tester, a member of the Tatanka Hotshot Crew, Black Hills National Forest*

New Fabric and Color for Pants

In continuation of the design changes for firefighter pants, a lighter weight material is now being used for the Type I pants. The fabric is the same twill weave and the same blend of fibers as the current Type I pant fabric—93 percent meta-aramid, 5 percent para-aramid, and 2 percent carbon fibers (Nomex IIIA). The new fabric is, however, one ounce (per square yard) lighter in weight than the current fabric—6.7 down from 7.7. Also, in order to accommodate firefighter feedback desiring a lighter color, the dark spruce color was changed to sage green (figure 3).

Figure 3—Type I flame-resistant pants are sage green and made of a fabric that is lighter in weight than the current fabric.

Availability of New Shirts and Pants

The shirt and pants ordering information, National Stock Numbers (NSNs) and National Fire Equipment System (NFES) numbers, will remain unchanged allowing the General Services Administration (GSA) and support caches to smoothly transition between the old- and new-style shirts and pants. Shirt and pants orders will be filled with the new styles after GSA depletes its inventory of old styles. Both the old- and the new-style shirts and pants are certified as NFPA 1977 compliant; either style is acceptable for fire use provided it meets other serviceability guidelines, such as cleanliness and condition. Fire shirts and pants can be ordered at <http://www.gsa.gov/graphics/fas/Interactive_PDF2012_Wildland_Fire_Catalog.pdf> or order a catalog at <http://www.gsa.gov/portal/content/101066>.

About the Authors

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John Smith joined MTDC as an equipment specialist in 2005 and was a project leader until his retirement in 2011. He graduated from the University of Montana with a bachelor's degree in education and taught elementary school in Ovando, MT. He began his Forest Service career in 1974 as a wildland firefighter for the Lolo National Forest's Superior Ranger District. A Missoula smokejumper for more than two decades, Smith applied his experience as assistant loadmaster foreman and master parachute rigger to developing equipment for firefighters.

Library Card

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Firefighters asked for work attire changes to improve fit, comfort, and durability. This tech tip describes changes to firefighter shirts and pants.

Keywords: fire, fire fighting, firefighting, flame-resistant, Nomex, PPE, protective clothing, safety at work, wear testing

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