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I am smart.
I am driven.
I will dominate my opponent.

I am an athlete.

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Predicting firefighter PPE

Probably more so than our ‘civis,’ we have a deeply personal relationship with our firefighting PPE.

And rightly so. It is our second skin, a barrier between us and the physical forces trying to kill us. Who hasn’t felt that twinge of separation anxiety when it’s time to exchange old turnouts for a brand new, squeaky-clean set? Who hasn’t marked that moment when those new turnouts leave the ‘getting to know you’ stage and become ‘my gear’?

When FireRescue1 and Fire Chief partnered with Globe to examine trends in firefighter PPE the idea to look at recent and current trends fell flat. Instead, we turned our focus to what the future trends are likely to be and how the present and past will inform and guide those trends.

Inside you’ll find our experts exploring how and why firefighter PPE is likely to change and taking an uncensored look at the NFPA standards process, which can be both barrier to and catalyst for PPE innovation. We also polled our firefighting community to better understand what’s important to those using PPE. We pulled out the most compelling results of that survey and discuss how they may drive future PPE trends.

— Rick Markley, Editor-in-Chief

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The fire service culture is one that embraces and is often defined by its traditions. Many of these traditions have helped establish a first-responder service that has unparalleled loyalty and commitment to those they serve and protect.

Nevertheless, many of the fire service traditions, while well-intended, can do more harm than good.

Certainly, there is an historical imagery associated with firefighters, particularly with what they wear. But as with all things, change has occurred and will continue to redirect the fire service into the future. This is particularly true for the entire area of personal protective equipment.

There are a variety of research programs, most of which are directed at short-term improvements in firefighter protective gear. Many of the changes are relatively incremental in the actual protective capabilities.

For example, there has been a trend toward greater insulation at a lower weight in outer shell materials used in turnout gear. Similarly, other materials such as those used in helmet shells and footwear are becoming lighter and providing more functional performance. These changes have had the effect of lowering the overall weight and stress impact of protective clothing.

Unfortunately, any decrease in overall system weight can be offset by adding new features elsewhere in the protective ensemble, which may add weight or complexity. The net effect is that the firefighter remains relatively burdened.
In fact, firefighter needs are evolving based on changes in their mission profiles as well as challenges being presented by new threats. The vast majority of the fire service has transitioned into the additional roles of rescue and EMS. Even those departments that do not provide basic medical services are still involved in the multitude of different technical-based operations.

**The changing mission**

Other industry shifts include structural fires fueled by more complex and dangerous combustion materials. And more departments are likely to be involved in wildland-urban interface fires and various specialized rescue disciplines. The variety of response hazards associated with these different missions creates a broader span of protection needs that is not always best served by a single set of protective clothing.

Firefighter concerns have also changed. Decades ago, firefighters were more concerned about being injured by burns and having gear that did not protect under routine firefighting conditions.

Now, with more capable, thermally insulated gear, firefighters can enter and stay in buildings longer than they did with even heavier clothing. Yet the price of these improved technologies means firefighters are increasingly exposed to dangers like structural collapses, running out of air, becoming disoriented within the fire building, and being exposed repeatedly to carcinogenic substances.

The increased rates of firefighter cancers are becoming the predominant issue within the first service. This is a significant change from even 5 to 8 years ago when the principal concern was getting gear that offered the greatest degree of mobility and breathability.

Not that lightweight, flexible clothing is any less of a priority, it is just that continual fireground exposures to hazardous substances is taking a visible toll on the fire service. Firefighters expect the personal protective equipment to prevent their exposures to contaminants, but do not want to encapsulate themselves to provide this level of performance.

As a consequence, trends in gear development are already starting to emerge. Obvious deficiencies in the current protective envelope are being addressed first. This means changing the way that firefighters approach the selection of their ensemble.

**Rethinking the ensemble**

It begins with having a protective hood that does more than simply interface between the SCBA face piece, coat and helmet. The hood itself has to prevent particle penetration and provide some level of resistance to fireground contaminants. Departments are addressing this matter through more frequent hood cleaning and replacement, but this is only a first step.

The new edition of NFPA 1971 attempts to move products in this direction. Yet there is a myriad of other related research focusing on product change to address protection from carcinogens. This will include new material properties to make clothing more contamination-resistant and focus on easier accessible cleaning to ensure proper decontamination.

The long-term future of PPE will likely require ensembles to evolve past the current piecemeal clothing approach where departments act as the integrators to put all the elements together. Instead, there will be greater focus on a system where manufacturers establish clothing ensembles that create a more uniform envelope of protection around the firefighter.

The prevailing background theme of low weight, high flexibility and improved comfort will still dominate material composite research and development.

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**CDC 2013 Firefighter Cancer Study Notable Findings**

- Firefighters had more cancer deaths and cancer cases than expected.
- This increase in cancer was primarily due to digestive, oral, respiratory and urinary cancers.
- There were about twice as many malignant mesothelioma cases than expected; asbestos exposure is likely in firefighting and is the primary cause of this disease.
- Some cancers occurred at a higher-than-expected rate among younger firefighters — firefighters less than 65 years old had more bladder and prostate cancers than expected.
- Increased bladder cancer mortality and incidence was observed among women firefighters.
Incremental changes discussed earlier will continue, but technologists and manufacturers will seek ways to constantly improve the protection-to-weight ratio of the overall gear system, increase mobility and limit heat stress. The industry will be faced with finding ways to better balance adding capability while reducing firefighter encumbrance. This is only achievable with improved equipment integration that works together as a system.

**Six priorities**

For example, there have been a few false starts at improved SCBA. SCBA also has become a platform for electronics integration, often unsuccessfully. The addition of sensing or communications capabilities to helmets equally has drawn criticism when conventional forms of these products are followed.

Thus, the long-term future of fire service PPE partly hinges on research to establish creative overall systems that incorporate emergency capabilities for addressing other first service needs. The convertibility of these systems to adjust to multiple missions will be seen as a great advantage in the future.

The future of PPE also hinges on the firefighting culture and its resistance to change away from what's traditional. Getting firefighters to accept nontraditional PPE may not be the greatest barrier to improved protection, but it is a barrier.

While a number of gadgets have made their way into the market, starting many years ago with thermal imaging cameras, the fire service has yet to see the full impact of sensor technology. Fireground accountability, firefighter tracking and reliable communications are part of the same direction to establish safer operations. Expect the future to include technology transfer from other fields into products that are fire service friendly.

During the next 5 to 10 years, look for these six PPE priorities.

1. Greater particle holdout capabilities in the protective ensemble, primarily in hoods and interfaces, with a minimum of firefighter encumbrance.

2. More attention to garment, helmet and other elements' weight, flexibility and comfort through more capable materials and components and through designs that better fit together with novel approaches to less stress-related wearing effects.

3. More emphasis on integrated clothing systems that include elements designed to be worn together more effectively.

4. Incorporation and standardization of ruggedized electronics capabilities in the ensemble for better communications, accountability and environmental sensing.

5. Equipment with a broader function across a range of first responder missions through new designs and system convertibility.

6. Clothing and equipment that is easier to clean and cleaning capabilities that make frequent maintenance and longer service life possible.

There are a multitude of research and product directions intended to provide immediate impacts versus those that are of a longer-term nature. The infusion of government money is helping on both fronts as are entrepreneurial efforts in commercial forums. In imagining where fire service PPE will be in 10 years, we are already seeing many of the clues around us in watching how technology is transforming entire industries.
What firefighters want from PPE

Firefighters weigh in on what functionality the next generation of protective equipment should and shouldn’t have

BY RICK MARKLEY, FIRERESCUE1 AND FIRE CHIEF EDITOR-IN-CHIEF

Earlier this year we invited the firefighting community to tell us what they liked, didn’t like and hoped to see in personal protective equipment. Our intent was to get a predictive understanding of how PPE development will trend in the coming years. Because the survey participants were not randomly selected, the results are not statistically valid. This means we can’t use the respondents’ data to project those views across the entire universe of firefighters. However, we were looking for patterns and insight, not trying to predict an election outcome. And the 1,222 firefighters who took the survey give us exactly that — a look into what is important to firefighters when it comes to their PPE.

Who Responded?

48% Volunteers

25% Career

24% Combination

2.5% Other

57% of the respondents held some level of officer rank

68% Departments with 60 or fewer firefighters

19% Departments with 100 or more firefighters
We asked firefighters to pick the most important thing they'd like their PPE to do and gave them some futuristic choices like the ability to track firefighters or repel carcinogens. Nearly half opted for PPE that would repel cancer-causing particles. However, only 36 percent said they wash their gear after every working fire. Also of note, 44 percent said they wanted their PPE to provide more protection from carcinogens, but not if it meant a more-encapsulating ensemble. About 18 percent chalked up the cancer risk to the hazards of being a firefighter.

We can take away from this that cancer prevention is moving to the fore of more firefighters' minds. Yet, there's a gap between wanting to be protected and taking steps like laundering gear — 12 percent said they rarely if ever wash their gear and 33 percent said they did it twice a year.

Surprisingly, given the high-profile attacks against firefighters, only 4.3 percent wanted PPE that protects against gunshot or knife attacks. Supporting this was another question that asked firefighters to stack rank 10 PPE attributes — knife and gunshot protection had the highest 'not important at all' ranking of the 10 with 22 percent. That aside, it wouldn't surprise me to see manufacturers roll out reflective ballistic vests for use on EMS and non-fire calls that can replace roadside safety vests.

Rounding out the one wish for future PPE question, firefighter-tracking technology beat out bodily vital sign sensing technology 32 percent to 20 percent.

When asked for their biggest gripe about their PPE, complaints of pockets and fasteners on coats and pants barely registered 5 percent collectively. Heat retention and restricted movement were the top two answers, pulling 28 percent and 24 percent, respectively. Rounding out the top three was weight at 17 percent.

Likewise, when we asked participants to stack rank what they'd like in their next turnout gear, lighter weight was the clear favorite with 45 percent naming it as their first or second priority. Better mobility came in second; it drew 37 percent of the first or second priorities. Interestingly, more innovations and cheaper price were among the three least-wanted changes to PPE.

When it came to structural firefighting boots, lower price and better innovation also were the lowest priorities. Weight, slip resistance, fit and flexibility — all performance issues — were tops.

Personal protective equipment has been trending toward reduced firefighter stress through better breathability, lighter weight and more flexibility. Look for this trend to continue. Also look for firefighter tracking and cancer risk reduction to play a larger role in next-gen PPE.

That's, at least, what the end users are asking for. If those desires can and will be met remains to be seen.
Changing the standards

Because the NFPA standard-making process is open to all, any firefighter can influence how PPE changes

BY JEFF AND GRACE STULL

When considering trends in and the evolution of firefighter PPE, it is critical to examine how changes to protective equipment get from the idea stage to the gear rack. One key to this process is having those changes written into the NFPA standards.

We have long advocated the value of standards covering PPE available to firefighters and other first responders. Although most standards are voluntary in most locations, they define a uniform basis for setting minimum requirements for how protective clothing and equipment are configured and, most importantly, the level of performance that it provides.

Despite their non-mandatory nature, standards have established the basis for how PPE manufacturers respond to the fire service. The industry has clearly recognized that the process by which the standards are created is essential to determining if, when and how protective equipment evolves.

Knowing how the standard process works and participating in that process is key to affecting the outcomes. The National Fire Protection Association strives to promote balanced membership on the committees with open access to any interested individuals.

Yet, we have found the committees can fall victim to believing they are the only ones knowledgeable enough for making these decisions. The majority of inputs and comments on proposed development of new or revised standards come almost exclusively from within the committee itself.
This is a disappointment because broader participation leads to better-quality standards reflective of all fire service needs. We would prefer that the standards process not be a closed-club endeavor.

**Potential changes**

There are some upcoming major issues under consideration for the next edition of NFPA 1971. This standard establishes requirements for structural and proximity firefighting protective clothing that includes turnout coats and pants, helmets, gloves, footwear and hoods. There are nine basic areas of new work.

- The application of testing requirements to helmet accessories.
- Changes in how glove thermal shrinkage and back of the hand insulation are measured.
- The inclusion of inspection openings in coats and pants to allow viewing the interior of the liners’ moisture and thermal barriers.
- More rigorous testing of proximity helmet gold-coated face shields.
- Investigation of an alternative for how garment breathability is measured for predicting the stress-related effects of clothing.
- The addition of improved liquid resistance for outer-shell materials used in coats and pants.
- Creation of the optional category for a barrier hood to block particulates from reaching the firefighter’s face.
- Establishment of an overall option to prevent smoke particles from infiltrating the firefighter ensemble.
- An explanation of test methods and requirements.

The responsible committee is also working on a variety of other changes to improve how testing is conducted and how the results are interpreted to ensure consistent ensemble element design and performance.

Even with adequate levels of participation, sometimes the standards process can be unwieldy and create problems for the industry. For this reason, significant new changes to standards are subject to an extra level of scrutiny put in place to ensure that the proposed revisions adequately address fire service needs. Primary among these new rules is the need for validation. Thus, any consequential proposed changes must meet four criteria.

- Relevance to the fire service addressing a specific identified need.
- Fully repeatable measurement techniques that certification laboratories who test clothing and equipment can implement.
- Data that shows testing approaches discriminate product performance to emulate what occurs in the field.
- An assessment of how the technology will impact the marketplace (not intended to limit new technology that radically changes available products).

**A deliberate process**

These new rules appear to make it harder to make changes to a standard. Instead, they are intended to avoid mistakes the committee has sometimes made over the past several years. For example, when the current 2013 edition was introduced in August of that year, a multitude of amendments and errata had to be implemented because some changes were not completely ready or thought out for implementation as part of the new standard.

Further, it is important to fully verify that requirements will work as intended to improve firefighter protection; this has not always been the case in the past. Sometimes new requirements can be design-restrictive and prevent new technologies from ever entering the marketplace.

There can also be concerns for how the standards affect the entire range of firefighters. While standards do provide a consistent minimum level of performance for firefighter protection, there is a cost, literally. New or onerous requirements do result in costs to manufacturers to add features or incorporate materials that can be more expensive than needed.

For example, beginning in 2007, a mandatory requirement was made to include a Drag Rescue Device

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**NFPA 1971 Revision Key Dates**

<table>
<thead>
<tr>
<th>Date</th>
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<tr>
<td>March 7, 2016</td>
<td>First draft report posting</td>
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<tr>
<td>May 16, 2016</td>
<td>Public comment closing</td>
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<tr>
<td>Jan. 16, 2017</td>
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<tr>
<td>Feb. 20, 2017</td>
<td>Notice of intent to make a motion closing</td>
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<td>April 17, 2017</td>
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<td>June 27, 2017</td>
<td>Appeals closing date for standard</td>
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<td>Aug. 10, 2017</td>
<td>Issuance of standard</td>
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in all coats to aid in the rapid extrication of a downed firefighter. The addition of this specific component adds approximately $100 to each set of gear. Yet, we are still attempting to identify any situation when DRD has been deployed and used successfully in a true emergency. That $100 could easily go towards a second set of gear or other department expenses.

While considered invaluable, the independent third-party certification along with all the testing to support that certification is a significant component of any manufacturer's overall product cost and is passed on to the fire department through increased sales price. Therefore, one of the balances in creating standards has to be the understanding for the true need of the requirement or product enhancement. Push back by the fire service is sometimes needed to bring realism to the fiscal impact of standards.

**Public comments**

There are also circumstances where the existing requirements in a standard restrict new technologies. As a case in point, a recent set of proposals was submitted to open up helmet design options by no longer requiring attached goggles or face shields.

We believe the committee's rejection of these proposals was premature, as issues related to helmet balance and functional performance have yet to be fully addressed in the North American market. Therefore, establishing a compelling case under the new rules can equally foster a better case for innovative change.

NFPA affords two key opportunities for outside participation in the standards process. The first of these is public input. Public input is at the beginning of the revision process and it is when anyone can put in a proposed change to standard that can be either simple or relatively complex.

Public comments are submitted online. The submitter must identify a section of the standard that they would like to change and to make the actual recommended change in the affected language as well as provide a substantiation for the modification. It is also possible to provide a global public input for an area that may not be addressed anywhere in the standard or one that addresses multiple areas for making several revisions of a common theme.

In some cases, attempting to navigate the standard and import public input can be daunting. Therefore, we recommend that you contact NFPA with questions about how to undertake this level of participation. We further recommend that you contact a committee member for assistance so they can help guide you through making a viable submission.

The committee reviews all public inputs and decides which will make it as first revisions to the standard. A new first draft of the standard includes all proposed changes that are accepted.

**Further adjustments**

This first draft then becomes available later for public comment, where further adjustments can be made to the standard. Public comments are submitted the same way as public inputs, but generally have to be connected with a first revision to the standard or a public input, whether it was accepted or not. The committee makes a similar deliberation on which public comments to accept. The results become the standard's second draft which is then submitted for full public and NFPA review.

Standards on fire service personal protective equipment are important for shaping the direction of the industry in terms of its clothing and equipment. It is important for more of the fire service to have a say in this process. Find ways to voice your opinions to these committees.

If you have criticisms or complaints, see changes that you disagree with, or wonder why certain technologies are not becoming available, there are ways to communicate these sentiments to the committee. The standards process and the products that evolve in response to that process only gets better when the mainstream fire service is engaged.
How to Conduct PPE Field Tests

PPE Update

How Turnout Gear Is Made

Fire Attack: Scene Safety & How Dirty PPE Can Hurt You

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Jeffrey O. and Grace G. Stull are President and Vice President, respectively, of International Personnel Protection, Inc., which provides expertise on the design, evaluation, selection and use of personnel protective clothing, equipment and related products to end users and manufacturers. International Personnel Protection, Inc. is considered one of the leading sources of expertise in the field of personal protective equipment. Mr. and Mrs. Stull are members of several National Fire Protection Association committees on personal protective equipment as well as the ASTM International committee on protective clothing. Mr. Stull was formerly the convener for international work groups on Heat/Thermal Protection and Hazardous Materials PPE as well as the lead U.S. delegate for International Standards Organization (ISO) Technical Committee 94/Subcommittees on Protective Clothing and Firefighter PPE. Mr. and Mrs. Stull participate in the government's Interagency Board for Equipment Standardization and Interoperability. Mr. and Mrs. Stull have written over 100 articles, chapters, and guides in the area of protective clothing and equipment. They have authored the book, “PPE Made Easy,” now in print by Government Institutes.

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Rick Markley is editor of FireRescue1 and Fire Chief, a volunteer firefighter and fire investigator. He serves on the board of directors of and is actively involved with the International Fire Relief Mission, a humanitarian aid organization that delivers unused fire and EMS equipment to firefighters in developing countries. He holds a bachelor’s degree in communications and a master’s of fine arts. He has logged more than 10 years as an editor-in-chief and written numerous articles on firefighting.
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