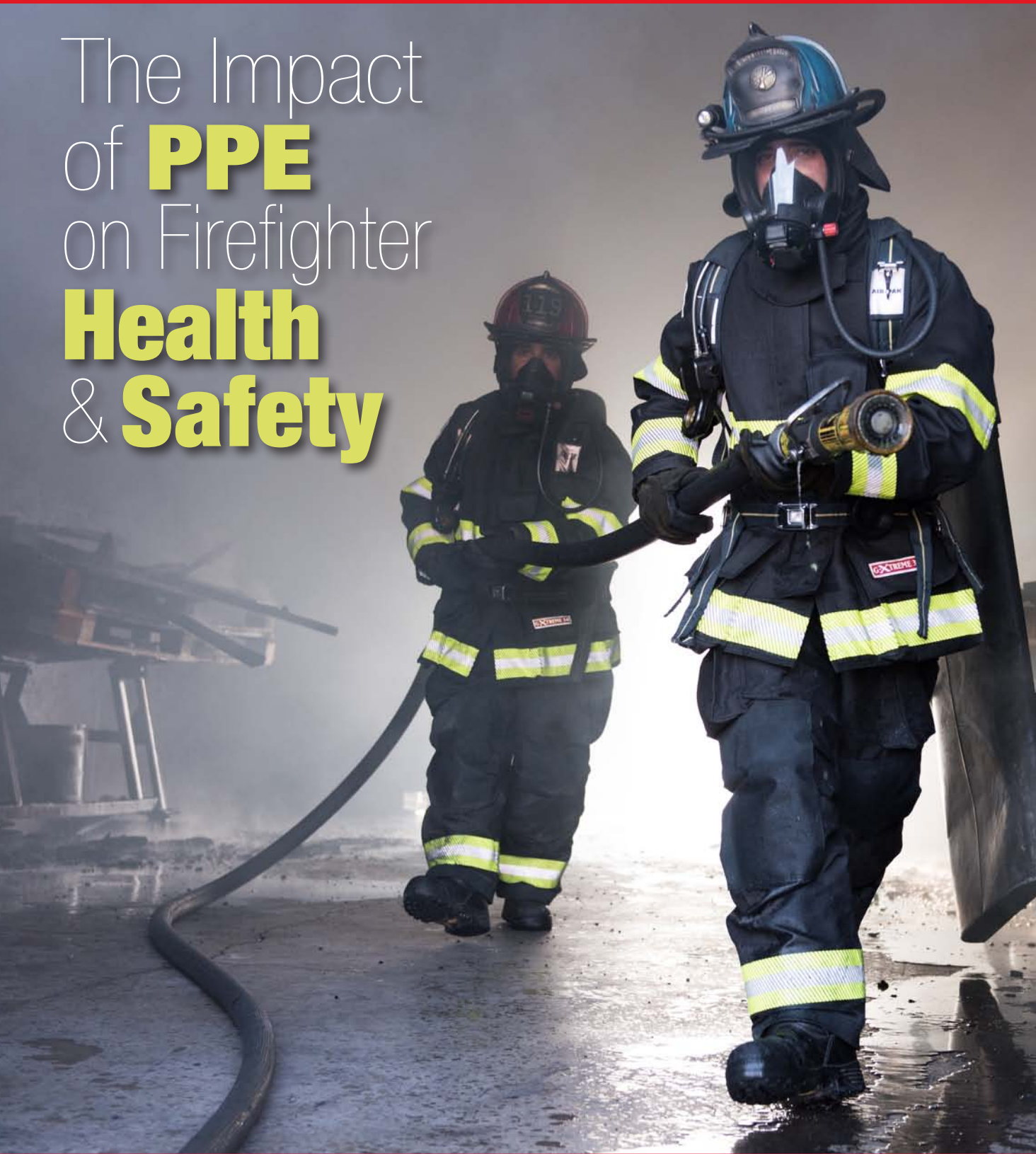


The Impact of **PPE** on Firefighter **Health & Safety**



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The Role of PPE in **Cardiovascular Health & Cancer Prevention**

Boston's Mission to Prevent Cancer

By Deputy Chief Greg Mackin

How one department aims to protect its members from unnecessary exposure to carcinogens



The Boston Fire Department (BFD) has a long and storied history, one that I—and every member of the department—is immensely proud of. Like every organization, the BFD from time to time needs to reevaluate itself in order to understand its strengths, identify its weaknesses and formulate a plan to meet present and future challenges.

For many years, the BFD lacked the adequate executive leadership and the support of the City's administration to successfully accomplish this. Fortunately, that changed when Joe Finn was appointed as fire commissioner/chief of department in July 2014.

New division, new focus

Through a wholesale review of the BFD, it was determined that the department lacked a comprehensive framework to ensure the safety, health and welfare of the membership. Finn wasted no time in creating the Safety, Health and Wellness Division, which is focused on making the department the foremost as it relates to the health and well-being of the membership and that is also empowered to undertake research and development of new equipment and tactics.

In creating this new division, the commissioner set the department on a new course and committed to having actions speak louder than words.

I had the great fortune of being placed in charge of the Safety, Health and Wellness Division. With the help and guidance of the commissioner, Local 718, the IAFF and, most importantly, the membership, we began to formulate a plan to deal with the many challenges that firefighters face from a health and safety perspective. Through our analysis, we determined that cancer, cardiac issues, and joint and muscular injuries were major issues that needed to be addressed. Comprehensive plans to deal with each of these issues were developed and implemented. One key element was the Firefighter Cancer Awareness and Prevention Program.

Cancer as the major threat

Occupational cancers are ravaging the BFD and the fire service in general. Statistically, 6 out of every 10 Boston firefighters will face a cancer diagnosis at some point in their lifetime, and some of them will not survive it. As a firefighter, I came onto this job understanding that going home at the end of a tour was not guaranteed. We accept

that some things are outside of our control. Buildings collapse, explosions occur, equipment fails, and while always tragic, they are not always preventable. What about things we *can* control? Do we not have an obligation to ourselves, our families and our friends to take the steps necessary, even if sometimes a little inconvenient, to ensure our long-term health? I would argue we should. At the BFD, we began looking at our cancer issue and decided enough was enough and something had to be done.

We had to first start by educating the membership about the problem and, in doing so, change the way our firefighters think. As a firefighter, we tend to make decisions based on what is going to kill me immediately. We put on a mask when we can't breathe anymore, and we take it off as soon as it looks like there is just enough oxygen to support life again. The same can be said of turnout gear, hoods or other life safety devices. When the immediate threat is eliminated, we relax and get comfortable. What we have come to learn is that when that immediate threat is gone, the threat does not end. Fire creates carcinogens; that is an indisputable fact. It does not matter if you are burning a pallet, straw or an entire

living room set. The byproducts of combustion may change in amount, but generally they are still present. Over time and multiple exposures, they build up in the body and you are eventually sitting in front of a doctor getting news you never thought you would get.

In order to educate our membership, we felt that creating a video and releasing it through social media would help us reach young and old firefighters alike. Partnering with embryocreative, we produced a first video that was designed to raise awareness. (The video can be viewed at <http://tinyurl.com/BFD-vid1>.) We wanted to show the effect that cancer has not only on the members but also the families and friends. Many members suffering from late-stage cancer agreed to tell their painful stories, and families re-opened wounds to illustrate the profound loss they experienced. Commissioner Finn, Local 718 President Rich Paris and Dr. Michael Hamrock all participated and added their stories and experiences.

Simultaneously, as we began the video production, we were also implementing changes in the department in regards to reducing exposure to carcinogens. The department completed a bunker gear census and found more than 75 percent of all bunker gear was not compliant. At the same time, we began an NFPA 1851-compliant inspection and cleaning program. Old and non-compliant gear was removed from service and new gear was issued. All members at this time have two fully compliant sets of bunker gear that are cleaned and inspected at least annually by an independent service provider (ISP). We also made cleaning of the bunker gear a requirement after a member works at a fire. This was initially through the ISP, but in partnership with the Kathy Crosby-Bell and the Last Call Foundation, extractors are being installed in every firehouse. The extractors give the membership another option in cleaning their gear. Firefighters can now choose to clean their gear themselves or send it out to be cleaned. We issued two hoods to each member and will shortly begin the process of issuing another set of boots and gloves to each member. New SOPs were issued regarding when and for how long masks should be worn. Post-incident



Post-incident cleaning wipes are available on every piece of BFD apparatus.

Photos courtesy Boston Fire Department

cleaning wipes are available on every piece of apparatus, and we are currently working on a comprehensive post-incident decontamination policy.

With all of these changes, we wanted to make sure the membership fully understood the changes and why they were being made. With the success of the first video, we believed that we should create the second video to outline all of the resources available to the membership to help in carcinogenic exposure. (The video can be viewed at <http://tinyurl.com/BFD-vid2>.) We were extremely lucky to have the support and participation of the same players from the first video, as well as Mayor Marty Walsh. In addition, Captain Joseph Adducci, himself a colon cancer survivor, spoke about the importance of taking the steps necessary to keep healthy. His ability to explain the issue from the perspective of somebody whose career has spanned decades illustrated the change in thinking required of veteran firefighters to ensure young firefighters take positive actions to stay active and healthy.

Thankfully, the message has resounded throughout the department, the country and the world. The videos have been viewed tens of thousands of times, and we have received messages from around the world. We are continuing to make changes, large and small, to ensure the safety of the mem-

bership. Cancer screenings are available to all members throughout their careers, in hopes of identifying cancers while they are still treatable. We recently completed an air-quality analysis in partnership with the Dana Farber Cancer Institute to fully understand the environment our firefighters are living in. We hope to have the results soon, and with them, make the firehouse a healthier environment. We are exploring diesel exhaust reduction devices in hopes of reducing the particulate matter firefighters are exposed to while operating in the firehouse. We are also looking at incorporating certain technologies into our bunker gear in the hopes of reducing particulate exposure, while not negatively affecting the breathability of the gear. While none of these are the complete solution, nor will they completely prevent the exposure to carcinogens, we hope that when taken as a whole they can make a significant reduction in the possibility of developing cancer. Only time will tell.



Boston's first video sought to raise awareness of the effects of cancer, not only on the members themselves, but also on their families and friends. The second video outlined the resources available to BFD members to help limit their exposure to carcinogens.

Cardiac still an issue

Cancer is only one of the issues that are affecting firefighters. Cardiac issues are also occurring with alarming frequency. Some are minor events that are easily treated, while others result in sudden cardiac death. The reasons why firefighters are more susceptible to cardiac episodes is a hotly debated topic with no definitive

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answer. There are, however, things that we can do to keep ourselves healthy. To that end, the BFD has instituted a health and wellness program aimed at keeping firefighters healthy—mentally and physically. To accomplish this, the department partnered with O2X to create a total health program, specifically designed for firefighters. O2X was founded by a group of former Navy SEALs who sought to leverage the lessons learned in U.S. Special Forces. Through this program, our members get hands-on training in developing healthier lifestyles. This includes developing better eating habits, dealing with the emotional hardships encountered as a first responder, and workout routines custom tailored to age and physical condition. So far, reaction to the program has been positive, especially with younger firefighters. Older firefighters also have been receptive and are participating in large numbers. We hope that by giving firefighters the tools to lead healthier lives, we can have a positive effect on their total health leading to a healthier, more productive membership.

In addition to the policy and procedural changes within the department, a key part of our strategy is actively participating in the industry. The BFD has reached out to the world-leading academics and researchers to fully understand the challenges faced by firefighters. We are participating in several national studies aimed at understanding and improving firefighter health. We have forged relationships with other departments to share information. In addition, we recently



Boston partnered with O2X to create a total health program, specifically designed for firefighters. Photo Courtesy O2X

hosted a symposium in conjunction with the IAFF specifically dealing with firefighter health and welfare. The symposium drew more than 350 participants from departments all over the country. Topics covered ranged from next generation bunker gear to substance abuse. We have been extremely encouraged and gratified by the feedback we have received and hope to hold other events in the near future.

What's ahead

While cancer and heart disease are currently our focus, we also are working diligently in other areas. One area is the development of new bunker gear specifications. We have felt for some time that the constant focus on thermal protection has had an adverse effect on a firefighter's physiological health. Recent studies have shown to some extent that this view is justified. There is also the issue of particulates and how they contribute to health issues. We have begun working on understand-

ing the physiological effect of bunker gear on the firefighter and how different composites increase or decrease physiological stresses on the body. We hope to use this information as part of our bunker gear selection process as another tool in evaluating our gear. In addition to TPP and THL concerns, we are also working on ways to protect firefighters more completely from the effects of particulate contamination. We have developed some testing protocols and are in the process of testing

some simple additions to our gear that may have a big effect on the ability for particulates to penetrate the gear without adding weight or affecting the gear's breathability.

Leading is about first understanding how to follow. We are taking the advice of scientists and the experiences of other departments to heart. This, combined with our own experiences, allows us to create appropriate policies and formulate better procedures, and more often than not, make the right decisions for the health and welfare of our firefighters. Unfortunately, the full benefits of all of our changes may take decades to fully realize; however, we are confident that the changes we are making today will have a profound impact on those who follow us in the future. In the end, it is up to each individual firefighter to embrace these changes. Much like building a house, we can provide the materials, but it takes skilled and knowledgeable men and women to make the house.

Greg Mackin is a deputy chief for the Boston Fire Department, heading up the Safety, Health and Wellness Division's efforts.

Integrated Research & PPE Development

“There is obviously a really significant big picture issue in the fire service today around health and wellness. The conversation started about cardiac events in the fire service and LODDs, and in the past few years, the awareness of cancer in the fire service has risen in a major way. With the overview of the big problems, we can get to what really is the voice of the customer and what it is that firefighters are really looking for when they think about PPE.

When you're doing an athletic activity—in this case, as a tactical athlete—you're doing high aerobic activity in a short but intense period of time. You're doing things like climbing 14

flights of stairs and carrying 80 pounds of equipment and pulling hose. By making that turnout gear less restrictive, it takes less work to do your job, so you're not fighting the gear.

Just reducing that workload has a direct consequence in terms of lowering core body temperature, which is really your physiological response to this work. Everything we can do to make it easier translates into less cardiovascular strain and makes it more efficient for the firefighter to do their job.

For many years, we've been involved as the industry partner in research projects with organizations like IFSI, Skidmore College, UL and NIOSH to really try and understand the exposure to carcinogens. After conducting multiple burns involving vari-

Research Shines a Light

By Dr. Denise Smith, Dr. Kenneth Fent, Stephen Kerber & Dr. Gavin Horn

Studies aim to better understand firefighters' physiological strain on the fireground

Firefighters face multiple dangers in performing their public safety mission. However, statistics reveal that the greatest danger firefighters face is the body's response to firefighting and the exposures associated with it.

Most duty-related fatalities are due to sudden cardiac events, and each year far too many firefighters are diagnosed with occupational-related cancer.

Our research agenda at the University of Illinois Fire Service Institute (IFSI) and Skidmore College has long focused on the physiological strain associated with firefighting, and understanding the influence of PPE on how the human body responds has been a major component of that research.

Balancing act

PPE was originally designed to protect against water. But, in more recent history, the primary function of PPE, especially turnout gear, has been to protect against thermal injuries. It is clear that PPE is absolutely necessary to protect firefighters; it guards against multiple hazards, including thermal insult, abrasions, puncture, and chemical exposure. However, PPE also adds a significant burden to the wearer, especially in terms of the weight, which increases work, and the thermal properties, which can



As part of the research, firefighters extinguished fires using either an interior focused attack in which they entered the front door and advanced the line to the fire in the bedrooms, or a transitional attack (initial knock down from the window before entering the front door). Photos by Peter Matthews/Firehouse

escalate heat stress. PPE can also negatively affect a firefighter's range of motion and how they move throughout the fireground (or any response where turnout gear is worn).

PPE manufacturers have long sought to increase the protection provided by PPE while limiting this burden. This has been a careful balancing act, as increasing performance on one end of this scale can also have adverse effects on the other side. Recently, with increasing awareness of the risks associated with chemical exposures,

there is new emphasis on modifying PPE to provide additional protection. Any changes to PPE must be balanced against the aforementioned factors that can interfere with job functions and increase heat stress.

Investigating exposures

At the IFSI, we have recently initiated a series of studies aimed at better understanding the risk of chemical exposures on cardiovascular health and cancer risk, and identifying the role that PPE plays in pro-

ous aspects of firefighting work, as well as training evolutions, we are left with several questions: What's the exposure for the firefighter during fire suppression? What's getting on the gear? What's off-gassing from the gear?

All of that information is critically important to categorize the problem and for us to engineer a solution. How can we reduce the egress of smoke inside the garment? We are identifying the contaminants from the smoke that are actually getting on the firefighter or getting in their body to understand what it is that we're trying to filter out—is it gas, is it particulates, is it both? What's the chemical composition, and how does that impact how we can develop materials and fabric and design in order to be able to solve some of those problems and reduce the exposure?

Problem-solving involves the user at the beginning, to understand what the problem is to be solved and really get their input in terms of what their experience has been like. And then in the process, we can go through not only the research part, but also do some iterations about suggested solutions and put those solutions back out to the firefighter for them to test and validate—and they usually come up with suggestions as to what needs to happen to make it work better for them. So it's a process where the end-users need to be involved throughout, from the beginning through the validation process, and then ultimately at the end we need to go through and tackle new problems to create the best gear. ”

— Mark Mordecai, director of business development, Globe



Left: As part of the 2015 research, the team monitored biological uptake of chemicals by collecting firefighters' blood, breath and urine. **Right:** In 2016, the research was extended to investigate the effects of different training situations on the same environmental factors, chemical exposures, and biological and physiological measures.

viding protection from chemical exposure. The "Firefighter Chemical Exposure and Cardiac Strain Research" projects address the two major health threats that firefighters face in a comprehensive way.

In 2015, we brought together five major research teams—IFSI, UL, NIOSH and academic researchers from Skidmore College and University of Illinois Chicago—to systematically investigate the exposures that firefighters face during typical scenarios on today's fireground. We instrumented a ranch-style home with common household furnishings and set fires in two back bedrooms. On different days we had firefighters extinguish the fires using either an interior focused attack in which they entered the front door and advanced the line to the fire in the bedrooms, or a transitional attack (initial knock down from the window before entering the front door). In coordination with fire attack, additional crewmembers performed search and rescue, ventilation, deployed ladders, operated the pump and managed the incident.

As part of the research, we monitored heat, gas and particulate matter in the air; measured contamination on turnout gear and on the skin; and monitored biological uptake of chemicals by collecting blood, breath and urine of firefighters. With these scenarios, we are now able to analyze our data to investigate the effect of tactics on environmental conditions affecting firefighters and potential victims as well as how tactics and job assignments relate to firefighters' exposures and physiological responses.

In 2016, the team reconvened and extended the research to investigate the effects of different training situations on

the same environmental factors, chemical exposures, and biological and physiological measures. In this experiment, we compared training fires in a metal container that contained theatrical smoke and digital fire simulation (no heat), a metal container with engineered wood (OSB), and a concrete building with straw and pallets.

The series of research studies has been critical to help us better characterize the cardiovascular and thermal strain associated with firefighting and understand the risks posed by those changes. By measuring multiple physiological factors, such as platelet function, coagulation, vascular measures and cardiac measures, we can better understand potential mechanisms by which the cardiovascular strain of firefighting is associated with sudden cardiac events during emergency operations. And by better describing the chemical exposures during firefighting—in the air, on gear, and on the skin, and what passes into the body—we can begin to better understand the mechanisms by which fireground exposures increase firefighters' risk for cancer.

More to come

These studies include multiple partners, incorporate realistic scenarios that firefighters routinely encounter, and benefit from the involvement and commitment of firefighters from across the country. While substantially more research is needed, these studies will be instrumental in informing PPE development, design and use, as well as guiding the development of standard operating guidelines (SOGs).

To learn more details on these studies, visit <http://tinyurl.com/IFSI-Interim-Report>.

What You Can Do

While we don't have all answers from our research—and much more detail will be forthcoming shortly—we know enough to encourage firefighters to:

1. Maintain a high level of fitness
2. Get medical evaluations that include screening for cardiovascular disease and cancer
3. Aggressively manage cardiovascular disease risk factors
4. Wear respiratory protection from initial attack through overhaul
5. Avoid the smoke plume and diesel exhaust and/or wear respiratory protection while on the fireground
6. Use good judgment and protect themselves from dermal exposures, including washing gear, taking a shower and ensuring that they employ good hygiene, such as using body wipes to clean hands and face/neck on scene
7. Apply water to the fire rapidly, and train on the application of a coordinated attack for successful response

Dr. Denise Smith is a professor at Skidmore College and a research scientist at Illinois Fire Service Institute (IFSI). She conducts research on the heat stress and cardiovascular strain associated with firefighting and strategies to increase performance and decrease cardiovascular events in the fire service.

Dr. Kenneth Fent is a research industrial hygienist at NIOSH. Much of his research has focused on characterizing firefighters' exposures to chemical agents and evaluating practices intended to reduce exposures.

Stephen Kerber is the director of the UL Firefighter Safety Research Institute. He has led research and education in ventilation, structural collapse and fire dynamics.

Dr. Gavin Horn is the director of IFSI Research and a firefighter/engineer with Savoy, IL, Fire Department. His research focuses on firefighter health and safety and first responder technology development.

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Store gear in a clean, dry, well-ventilated setting that's away from direct sunlight or any UV-producing lights.
Photo by Gert Zoutendijk

Clean, Maintain & Store

By Patricia Freeman

A health-conscious approach to PPE cleaning, maintenance and storage

The fire service has become extremely health conscious—and rightly so. Proper cleaning, maintenance and storage of protective clothing are essential to improving firefighter health and safety. However, there are some misconceptions about PPE that could hamper a firefighter's ability to take a health-focused approach to these topics. With that in mind, let's dispel a few myths with facts.

Myth: If I launder my gear too frequently, it will lose some of its flame resistance.

FACT: The special fabrics that make up your three-layer turnout system, regardless of manufacturer, will NOT lose heat or flame resistance regardless of how many

times they are laundered. These characteristics are inherent to the base fibers, meaning they cannot be washed out or dissipate with use.

Myth: Dirty gear is the sign of a seasoned veteran.

FACT: Dirty gear is the sign of an uneducated firefighter. The truth is that the byproducts of combustion are combustible. Even with the inherent characteristics, flame and heat resistance can be compromised if the garment is worn in an extremely soiled condition. For example, a fiber such as polybenzimidazole (PBI) will not normally ignite unless in the presence of a super oxygen-enriched environment.

However, if a PBI fabric was dipped in diesel fuel and then subjected to flame, the fuel would burn until there was nothing left, resulting in the PBI shell fabric becoming totally consumed. Additionally, firefighters are subjected to many different chemicals and contaminants, all of which can be absorbed into the protective gear and many of which are hazardous to the firefighters' health. Advanced cleaning of protective gear is imperative to protecting the firefighter.

Myth: Where I store my gear is more important than how I store my gear.

FACT: Where you store your gear and how you store your gear are equally

important factors. Gear that is stored wet, or is stored where moisture is present, can develop mold and other fungi. Additionally, storing soiled gear will cause impurities to become more deeply imbedded into the fabric fibers. If you are storing soiled gear, you are also storing all of the contaminants that may be present in that gear.

Myth: As long as I rinse my gear after every exposure, there is no need to launder further.

FACT: While rinsing at the scene is very effective in removing surface soil and debris, it does not take the place of an advanced cleaning. NFPA 1851 breaks cleaning down to two levels: routine and advanced. Routine cleaning is done by the wearer at the scene and does not use or require any mechanical action. Advanced cleaning is always done with a mechanical action (i.e., extractor) and is required to be done at least once a year as a minimum or whenever a routine cleaning is obviously insufficient to remove dirt and grime. Rinsing with cold water (routine cleaning) is simply not sufficient enough to remove all of the contaminants to which firefighters are regularly exposed.

Myth: Small tears, burns or cuts in my protective gear can be ignored as long as they are just minor.

FACT: A breach in any layer of the protective clothing must be addressed immediately. Smoke, chemicals, heat and other hazards of firefighting can enter through any rupture in the protective envelope, regardless of how seemingly insignificant.

Myth: My backup gear is not as important as my primary set, as it is only used if my principal gear is for some reason unavailable.

FACT: Your “backup” gear becomes your front line gear the moment you don it, and it must be treated with the exact same care and maintenance as your primary set of gear. Any protective gear should be considered as your primary protection.

Dispel the myths

So how do we dispel the myths and care for protective clothing? The following requirements are per NFPA 1851: Stan-

dard on Selection, Care and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting, 2014 Edition. *Note:* This standard is quite a comprehensive user document, and all fire personnel should read it to get a fuller picture of PPE cleaning, maintenance and storage.

The proper way to perform advanced cleaning (machine washing):

- Front-loading washing machines (aka extractors) are preferable.
- Do not overload the machine.
- Pre-treat heavily soiled or spotted areas.
- Separate outer shells from liners, remove drag rescue devices and suspenders, and wash independently.
- Turn the liner system inside out.



When performing advanced cleaning, separate outer shells from liners, remove drag rescue devices and suspenders, and wash independently. Photo by Gert Zoutendijk

- All closures (zippers, hook and D-rings, plush and loop) must be fastened prior to laundering.
- Water temperature should not exceed 105 degrees F.
- Use mild detergent (pH factor of 6.0 to 10.5), as indicated on safety data sheet or product container.
- Adjust the washing machine so that the g-force does not exceed 100 g (follow machine manufacturer instructions for proper setting or program selection).
- Inspect after cleaning and rewash if necessary.
- Dry in an area with good ventilation; do NOT dry in direct sunlight.

- Ensure that all closures are fastened prior to drying.
- If machine drying, do not overload capacity of machine; use “no heat” or “air dry only” option.
- If machine drying, basket temperature should not exceed 105 degrees F.

The proper way to store gear:

- Store in a clean, dry, well-ventilated area.
- Store away from direct sunlight or any UV-producing lights.
- Do not store in temperatures above 180 degrees F or below -25 degrees F.
- Do not store in vehicle trunks, unless protected by a gear bag or other covering.
- Do not store in airtight containers, unless new and unused.

- Do not store in contact with oils, solvent, acids, alkalis or other contaminants.
- Do not store in personal lockers or living quarters.

The proper way to maintain gear:

- Gear should be routinely inspected after each use, by the wearer, looking for any signs of damage. If any type of damage, discoloration or degradation is present, the garment should be forwarded to the safety officer or other authority having jurisdiction for further assessment.
- NFPA 1851 requires any field repairs to be performed by the original manufacturer, a verified independent service pro-

vider (ISP), or a member of the department who has had the required level of training.

- All repairs shall be done in like manner as manufacturer using NFPA-compliant materials.
- Basic repairs shall be limited to the following: patching of minor tears, char marks and ember burns; repairing of skipped, broken and missing stitches; replacement of missing hardware, excluding hardware that is part of positive closure system; reclosing of the liner of a garment after complete liner inspection.
- When performing repairs, remove the liner system from the outer shell to avoid accidental damage.
- Repairs must be made to all layers of the garment that have been damaged. If there is a tear or burn in the outer shell, check the thermal liner and moisture barrier to make sure these layers were not affected.
- Patches shall be limited to 32 cm² (5 in²). The finished edges of a patch shall extend at least 1 inch in all directions beyond the damaged area, with no raw edges on the patch to prevent fraying. A patch should be large enough to allow for turning under all edges at least a half-inch on each side.
- Where installing a patch to the outer shell, it is recommended that the inte-



Gear should be routinely inspected after each use, by the wearer, looking for any signs of damage. Photo by Ed Ballam

rior of the fabric be patched as well to prevent further damage from washing and general wear.

- If replacing trim or covering trim with an option, any covered trim must be replaced. Trim patches must not exceed 3 inches in length and must extend 1 inch beyond the damaged area, with a maximum of 2 patches per trim stripe allowed.
- Re-stitching more than 1 inch of an outer shell Major A seam, or a thermal liner Major B seam, requires consulting the manufacturer.

- Repairs to moisture barrier seams require consulting the manufacturer.
- Manufacturer should always be consulted if unsure of the complexity of the repair.

In sum

PPE is a critical line of defense against the dangerous environment in which you perform your duties. Keeping your gear clean, well maintained and properly stored contributes to your health and safety. ■

Patricia Freeman is the technical services manager for Globe Manufacturing Company.

Educating Customers about PPE

“How do you make sure that the gear is well maintained and cleaned properly? That involves educating each individual end-user. It's not just a department question anymore; it means the user needs to understand the limitations of their gear and how to keep it so it will continue to protect them for a long time to come. That educational process is ongoing and continuous—it's a big deal that we take very seriously.

In terms of the gear itself, because of the amount of carcinogens and the impact on firefighters, there's much more understanding that dirty gear is not a badge of honor; it is dangerous. Firefighters need to take appropriate action after every exposure with their gear, whether that's some kind of field decontamination or being able to put it through an extractor, depending on what the exposure is. Some of that is a cultural issue that's starting to gain some traction. People are understanding that's not how you want to look; that's how you want to avoid looking as you move forward. And the firefighter can't contribute to the problem by continuing to wear gear that is

dirty and contaminated. That's easier said than done. It requires two sets of gear in a busy department. It also means that they have to have a process where gear can be cleaned regularly and frequently, and there's a consequence to doing that.

Turnout gear doesn't last forever; no protective product does. But when you think that it's often worn every day for hours at a time, for years, it's got a tremendous service lifetime, even if that lifetime isn't forever. And the more it's exposed to everything—chemicals, sunlight, fluorescent light, contaminants, washing—all of those degrade the product. So it's not realistic to think that if you washed it every day that it was going to stand up and last as long. But if you're getting involved in serious exposures, you need to make sure that those are addressed and that the gear remains clean or else the sacrifice isn't to the gear anymore; it's to your health and the health of the other firefighters on your team.”

— Mark Mordecai, director of business development, Globe



8 STEPS

to Specifying PPE for Firefighter Health and Mobility

By Mark Dolim

Minimizing the occurrence of cardiac events as well as burn injuries and fatalities

Photo by Glen Ellman

The number one killer of firefighters is sudden cardiac events resulting from stress and overexertion, with the majority of these events taking place during and/or shortly after fire suppression. But burn injuries and fatalities are also a constant threat, so how do you minimize the occurrences of both?

1. Revisit your current PPE specifications

For many departments, PPE specifications are a series of historical accidents, sometimes going back as far as 20 years. Is there anything else that hasn't changed in 20 years? NFPA standards have been revised many times during this period. Department priorities and standard operating procedures (SOPs) have likely changed. The tools firefighters carry to perform their

duties have changed. PPE materials, technologies and ensemble designs have certainly changed. Solutions to address these changes should be reflected in PPE specifications—and those specifications should be reviewed regularly.

Look at the many new materials and technologies recently made available to the fire service, and learn how they can improve the firefighters' ability to work with less stress on their bodies, and still provide the protective envelope necessary to do the job.

2. Acknowledge that firefighters are tactical athletes

You may not think of yourself as an athlete, but you punish your body in exactly the same way that athletes do during training and in the skillful performance of your duties. Like any sports athlete, when you are pushed to perform, your heart rate and respiration rate increases, and your body will try to cool itself by sweating as



Firefighters are expected to perform a variety of movements in demanding environments, highlighting the importance of gear that moves with the body and supports decreased stress on the wearer. Photo left courtesy of Globe Manufacturing Company; photo right by Glen Ellman

much as possible. But a host of factors conspire to put physiological stress on your body; that includes wearing protective and insulated clothing.

Just like it would be for any athlete, it's a lot easier to perform at your best and expend energy longer when your clothing is lighter in weight, fits properly and can allow for a full range of motion. It's what we call a "balanced" garment.

What sets you apart from sports athletes is the diverse and often dangerous environment in which you are working. It may be working a structural fire with dramatically elevated interior temperatures, or out on the highway in the blazing sun or during a howling blizzard. These variables, and others, are major considerations when selecting your PPE ensemble.

3. Investigate new technologies that enable greater performance

Today's turnout elements are better than ever, and the wise selection of each element will allow a firefighter to perform better than in the past—and with an increased safety factor. There are new materials available for the three-layer composite—outer shell, moisture barrier and thermal liner—along with new materials being used in hoods, boots and gloves.

New outer shell and thermal liner materials from Safety Components and TenCate Protective Fabrics are using NOMEX and KEVLAR filament in place of spun yarns. Using filament allows the shell to be more flexible and drape—or hang—on your body much like the everyday clothing in your closet that you find most comfortable. When combined with a thermal liner also using filament, a system is created that allows the firefighter to work with less effort and, therefore, lessen exertion and reduce heat buildup inside the gear.

In high-heat stress situations, the body can produce more heat than it is able to lose, which increases the body core temperature. Studies have shown that what might seem like small increases in body core temperature can impair decision-making, muscle control and hearing accuracy, eventually leading to heat stroke, all of which can compromise firefighter safety and effectiveness.

4. Get familiar with turnout gear performance test methods

For years, thermal protective performance (TPP) and total heat loss (THL) have been the measuring yardsticks for evaluating how well a turnout jacket and pants will deliver protection from heat (TPP) and

breathability (THL) when working.

Recently, we have heard more about the Resistance to Evaporative Heat Transfer (RET) test, which measures the ability of the jacket and pants to allow the heat and sweat your body creates to evaporate out and away from your body in more real-world conditions. The RET test is unique in that it can measure performance at different temperatures and humidity levels than the THL test. While the RET test is not required by the 2013 edition of NFPA 1971, it is a well-known test method used in studies performed by the military.

5. Rethink weight factors

Misconceptions about the weight of turnouts are still common, with many people assuming the lighter the turnouts, the better. Maybe, maybe not. Balance and ergonomic design are much more important considerations than just the net weight.

Making lightweight, balanced gear that delivers stress-reducing flexibility and range of motion requires a designer to add the curves and flex points where needed. Ergonomic garment designs will allow the jacket and pants to not only interface with one another, but also with your boots, hoods and gloves. Gear that causes restriction or compression when moving can lead to hot spots and potential burns.

And let's talk about tools. Firefighters often carry tools in their turnout gear that weigh more than 10 pounds, often exceeding the weight of their jacket and pants combined. Do yourself a favor and start by laying out on the floor everything you keep in your turnout gear pockets. Then pick up each piece and see if it really still speaks to you about how essential it is for you to have it with you at all times. If you don't absolutely have to have it, don't put it back in your pocket! By carrying tools that are not absolutely necessary, you are not just stressing your gear, you are stressing yourself as well.

6. Conduct a PPE field wear test

Insist upon a wear test. Well-designed gear is tailored to fit and move with your body. You want the arms and legs to move easily! To do so, the torso of the jacket and seat of the pants need to be designed to allow for body movement. The gear that is most comfortable will often be perceived as lighter in weight when, in reality, it is just a better balanced garment and a superior ergonomic design.

Your wear-test protocol should

mimic the real scenarios of firefighting—swinging an axe, climbing a ladder, crawling and overhauling with a pike pole, to name a few examples. By performing these routine duties, you will be able to evaluate which materials and designs meet your specific needs best.

7. Aim for consistent protection across ensemble elements

Take a long, hard look at the continuity of your PPE ensemble. Are you selecting a turnout outer shell with high resistance to flame impingement? Are your hood and wristlets comparable in their ability to resist that level of impingement? And with carcinogens finally ascending to the level of concern they deserve, it might be time to look at hoods that have a greater ability to filter some of the carcinogenic particulates that have been passing through the layers of the knit hood.

NIOSH studies have shown that boots make a difference in firefighters' agility and how much energy they expend when working a call. Boots that are lighter and more flexible and really fit take much less effort to work in, deliver a greater degree

of surefootedness, and lessen the likelihood of trips and falls.

8. Enlist the services of industry experts

We are at a juncture where gear is finally allowing firefighters to perform like the tactical athletes they are.

Especially for those individuals on PPE and safety committees who are evaluating and selecting gear, dive in and dive deep. Don't be intimidated by the jargon and the science. Enlist the services of your local dealer, garment manufacturers and material suppliers. They are valuable resources to help you evaluate how technological advances may benefit your department and improve firefighter safety and protection.

Take the time to review with them any issues, trends or problems with your current turnout gear.

In sum

Now is a good time to update your specifications with new material choices, new technology and new levels of ergonomic designs that can really make a difference to your department, your team and you. ■

Mark Dolim is the national sales manager for Globe Manufacturing Company.

Designing PPE with an Eye on Athletic Wear

“This is a really exciting time in the development of PPE because there is all new technology and materials and material science that is now enabling new design.

Historically, the way we reduce restriction and make less strain on the firefighter when they are doing their activities is to add fullness and length where the body bends so you aren't restricted when you are moving, when you're pulling a ceiling, when you're crawling, when you're going up stairs. That's because materials didn't stretch, so the only way to allow you to make those kind of movements and get less restriction was to make sure that we're patterning them in ways that allow freedom of movement. But what if your materials could stretch? How would that change how you could design gear?

When you think about firefighters being tactical athletes and how they do their job, you want gear that's going to move with you and that's closer fitting and that would be more like what you would be using for all of your other fitness and outdoor activities.

And with the availability of some new stretch fabrics that we're just introducing to the market, now we don't have to add all of that extra bulk. We can make turnout gear that is closer fitting to the body. And by being closer fitting to the body and by adding stretch, we are now able to reduce the restriction, without having to add all of the excess and, consequently, we can make gear that is significantly lighter and that moves with you because the fabric moves as well as the way the garment is designed.

This is something that enables a completely fresh approach to how you are going to dress to do your job. And it's a whole different silhouette, which is more body contoured, more athletic and less bulky. When you see firefighters today wearing their SCBA and all of that excess material, where does that go? It all bunches up underneath your SCBA because it has nowhere to go, so stretch is very exciting from a design standpoint.”

— Mark Mordecai, director of business development, Globe



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