Chairwoman Comstock, Ranking Member Lipinski, and members of the Subcommittee, thank you for the opportunity to participate in this important discussion today.

My name is Gavin Horn and I am the Director of Research at the Illinois Fire Service Institute. The Illinois Fire Service Institute (IFSI) is the statutory State Fire Academy for Illinois. Since 1925, first responders from across the state and world have relied on IFSI to deliver hands-on, innovative, and top quality training, education, and research. IFSI is an Institute within the University of Illinois at Urbana-Champaign, a co-location that allows collaboration between research faculty and students with broad scientific expertise and the applied fire service knowledge to tackle fire related problems that face our nation. IFSI houses a nationally recognized research program devoted to firefighter health and safety and has lead or is involved in a number of large-scale projects focused on improving firefighter health, safety and effectiveness across the spectrum of fire department capabilities and responses. A key aspect of this work is the opportunity to collaborate nationally and disseminate research results to the fire service in a manner that can be effectively implemented. I am a member of the National Fire Protection Association's (NFPA) Technical Committees on Special Operations Clothing & Equipment and Fundamentals of Fire Control within a Structure Utilizing Fire Dynamics, a member of the Board of Trustees for the Fire Protection Research Foundation (FPRF), and a member of the Advisory Board for Underwriter Laboratories (UL) Firefighter Safety Research Institute.

I was invited to participate today to discuss the following three topics:

1. Priority needs for the fire safety of the nation
2. Effectiveness of the FIRE and SAFER grant programs in addressing the needs of the fire community
3. Recommended improvements to the grant programs or the U.S. Fire Administration.

In this testimony, I will focus my comments on the American research enterprise that is supporting the fire safety of the nation through the FIRE grant program and in particular the Fire Prevention & Safety (FP&S) grants. Specifically, I will provide a perspective regarding setting research agendas and identifying research priorities broadly covering fire protection and fire safety for fire departments, communities and the safety of the nation. Although several research agenda have been developed to support domestic emergency response, I've been asked to touch on current research priorities that focus on fire service response related to the FIRE grants. My remarks will focus on progress that has been made on these research agenda items as it relates to the FIRE grants program – particularly the Assistance to Firefighters (AFG) Fire Prevention & Safety (FP&S) activity. While a relatively small component of the overall AFG program, the FP&S activities are unique in that they support national programs as opposed to direct funding of local capabilities. Indeed, they are the only national funding program specifically devoted to enhancing the health, safety and effectiveness of the responders who protect our communities.

## Background

The U.S. Fire Service is facing an important crossroads in the coming years. The number of fires in the United States has decreased by 59% since 1977[1]. Civilian fatalities have decreased in a similar magnitude, reaching historic lows in 2012[1]. Despite these positive trends, the challenges facing the fire service community are substantial; including the size and construction of new homes and the proliferation of synthetic, petroleum based products that are ubiquitous in homes and businesses. As a result, fires grow more rapidly, reach flashover more quickly, and release more toxic gases at the scene New capabilities around homeland defense are being added to responsibilities of fire prevention and suppression, hazardous materials, search and rescue, and medical response; and budgetary constraints often mean financial resources are severely limited. The fire service is in desperate need of federal funding to advance research that supports evidence-based policies to address long-standing issues in a dangerous occupational sector that has not historically been supported by research, and to address emerging risks and hazards as the fire service responds to new realities around fire risks, and new operational response scenarios.

There have been many important improvements in fire service practice and in the health and safety efforts in the fire service. However, much more needs to be done to protect firefighters as evidenced by the fatality and injury statistics that are reported each year. Practices and innovations within the Fire Service, such as seatbelt usage, increased SCBA use, some improved health and wellness activities, and widespread adoption of the Incident Command System have likely led to fewer avoidable injuries and fatalities and more effective fireground operations. Comprehensive research into complex problems, evidence-based policies, good training tools, technology enriched solutions and novel interventions must continue to be developed to support the Fire Service – and this need is made more urgent in a time of scarce resources and competing mission requirements.

Largely due to recent, AFG-supported research projects, significant advances have been made in in recent years that have a direct and profound impact of FF health, safety and operational effectiveness.

1) Our understanding of the hazards associated with structural firefighting have increased dramatically. Research has provided a greater understanding of the development, propagation and dangers of modern residential fires – and often this research based understanding is in opposition to what had been historically "understood" by firefighters to be how fire behaved. The lack of understanding of the fundamentals of fire behavior puts every firefighter at grave risk. Research into fire behavior and the hazards it produces remains a fundamental need of the fire service.
2) Our understanding of the protection needed from PPE and the physiological burden imposed by the gear has led to newly designed protective gear, and important tactical guidance that increases firefighter effectiveness while decreasing risk. New materials and a better understanding of the physiological risks of firefighting make this a fruitful area of research to continue to explore.
3) Our understanding of the cardiovascular risks associated with firefighting have increased dramatically. We know that sudden cardiac events are the leading cause of duty-related deaths among firefighters and they are far more likely to occur after fire suppression activity than station duties. Substantial evidence shows convincingly that firefighting leads

[1] http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/fires-in-the-us/overall-fire-problem/trends-and-patterns-of-us-fire-losses

to high levels of cardiovascular strain. Ongoing research is exploring the causes of cardiovascular events - such as plaque rupture and arrhythmias- to better inform medical screening procedures. Research efforts to better describe the physiological demands of firefighting and how to support peak physical performance of individuals doing arduous work are critical in the fire service – just as they are in the military.

4) Our understanding of the chemical/toxic exposures that firefighters face is just coming into focus along with studies documenting that firefighters have an increased risk for several types of cancer. Fires produce hundreds of toxic compounds, and some are carcinogenic like benzene and certain polycyclic aromatic hydrocarbons (PAHs). Research is needed to identify exposure routes and to develop effective mitigation strategies to decrease exposure risk.
5) Our understanding of the post-traumatic stress impact is just now developing. Our awareness of firefighters risk for substance abuse and taking of their own lives is causing great alarm within the fire service and is an area that requires additional research.

Many risks are known, and significant progress has been made, yet risks continue to change, and the fire service needs to be able to respond. Our response theatre grows increasingly diverse and increasingly complex as building construction techniques continue to change, often driven by affordable housing and energy efficiency concerns. The fuels in our structures continue to change, driven by comfort, consumerism, economics and marketing. The Fire Service continues to expand and take on new challenges outside of traditional fire suppression, including rescue and medical tasks along with high risk, low frequency response such as hazardous materials and homeland security responses – and importantly leading the way in many jurisdictions in fire prevention efforts. And the risks from outside the traditional response theatre including violent incidents where weapons have been utilized against firefighters while battling blazes or medical emergencies, are driving a demand for changes in protection beyond the traditional thermal considerations. As all of these changes occur around us, the fire service needs to remain adaptable in the face of declining budgets and/or declining membership/volunteerism in some parts of America. A national research program, guided by fire service and researchers alike and funded through national programs such as AFG, can guide the development of new tools, technologies and techniques at a pace that can keep up with the surrounding changes. Without such a program, our capabilities and our safety will lag.

**1. Priority *Research* needs for the fire safety of that nation supported by FIRE grants**

A variety of organizations and stakeholders have developed a series of needs analyses and research agendas to support the advancement of capabilities, health and safety of the fire service in the face of this changing risk profile. While this process has a long history – dating back to America Burning and beyond – I will limit this review to work that has been conducted in the past 10-15 years. What follows is not a complete treatment of all analyses that exist, but covers those that I believe to be most applicable to the FP&S grant program of interest today.

### 1.1. Technology centric needs analyses – Emergency Responders:

- **Project Responder series** - *Project Responder 3: Toward the First Responder of the Future*[2] and *Project Responder 4: 2014 National Technology Plan for Emergency Response to Catastrophic Incident*[3] – Building off the original 'Project Responder' report in 2004, and prepared by the Homeland Security Studies and Analysis Institute for the Department of Homeland Security Science and Technology Directorate (DHS S&T) in 2012, Project Responder 3 focused on identifying gaps between current emergency response capabilities and those required to respond to *catastrophic events*, and included a prioritization of areas of investment to fill these gaps. The study identified 12 broad priorities across all first response disciplines, and these top 12 priorities are further divided into three tiers with Tier 1A representing the capability gaps of the highest importance. Project Responder 4 expanded this list to 14 priorities around the broad areas of situational awareness; communications; command, control and coordination; responder health, safety and performance; logistics and resource management; casualty management and training and exercise.
- ***The Interagency Board R&D Priority List***[4] **–** The mission of the InterAgency Board for Equipment Standardization and Interoperability (IAB) is to strengthen the nation's ability to prepare for and respond safely and effectively to emergencies, disasters, and chemical, biological, radiological, nuclear or explosive (CBRNE) incidents. Each year, since 2007, the IAB, through its membership, has generated a priority list for the future of research and development. Many of these topics directly or indirectly support the Fire Service. This priority list is largely focused on technological solutions for responder needs.
- Consistent among these series of analyses is the high (often top) prioritization given to the need to locate responders in real time during an incident. This remains a priority that has received significant investment, including through FP&S R&D grants, but where much work is still needed.

### 1.2. Building centric needs analyses – Fire and Fire Protection:

- The **National Institute for Standards and Technology (NIST)** has conducted a series of needs analyses, identified gaps, and established priorities detailed in the *Reducing the Risk of Fire in Buildings and Communities: A Strategic Roadmap to Guide and Prioritize Research* report[5] that built off earlier projects that prioritized building intelligence needs[6,7] in addition to the measurement science research needs highlighted here.

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[2] http://www.nisconsortium.org/portal/resources/bin/Project_Responder_3:_1423591018.pdf
[3] https://www.dhs.gov/sites/default/files/publications/Project%20Responder%204_1.pdf
[4] https://www.interagencyboard.org/publications/priority-lists
[5] *Strategic Roadmap for Fire Risk Reduction in Buildings and Communities*.
http://ws680.nist.gov/publication/get_pdf.cfm?pub_id=909653
[6] Workshop to Define Information Needed by Emergency Responders During Building Emergencies.
http://fire.nist.gov/bfrlpubs/fire05/PDF/f05017.pdf
[7] Delivering Building Intelligence to First Responders.
http://ws680.nist.gov/publication/get_pdf.cfm?pub_id=903815

- ***Changing Severity of Home Fires***[8] **-** In 2012, the U.S. Fire Administration invited leading national organizations representing the Fire Service, fire researchers and other stakeholders in home fire safety to explore how changing building contents, construction techniques and firefighting tactics are affecting the way fires grow and develop in today's homes. These stakeholders jointly developed an eight-point action plan to summarize identified risk reduction strategies, including certain strategies based upon novel technologies.
- ***Fire Protection Research Foundation's (FPRF) 2014-2019 Research Priorities***[9] **-** The Fire Protection Research Foundation plays an important role with the FP&S R&D grant program, helping to support connections between academic research and the fire service community in a wide range of research topics and then assisting in translation to NFPA standards where an appropriate part of project dissemination. With input from members of NFPA technical committees, staff, and leadership, the FPRF developed a series of research priorities in 2014, building off their 2008 research agenda. The stated goal is to identify emerging challenges for NFPA standards and how the Foundation can develop research information to help address those challenges. These priorities sit at the intersection between building centric and firefighter centric needs and include;
  - Expanding focus to include developing strategies to reduce residential fire losses
  - Developing fire safety strategies for changing social demographics
  - Developing fire safety strategies for sustainable, resilient communities
  - Developing guidance for fire fighter tactics to adapt to emerging technologies and strategies
  - Facilitating research, development and use of cyber physical systems and integrated technology/systems for fire safety
  - Exploring strategies to integrate fire safety into emerging health and safety cultures
  - Assessing the factors that impact the effectiveness of fire protection systems

**1.3. Firefighter centric needs analyses:**

- ***The National Fire Service Research Agenda***[10]– Led by the National Fallen Firefighters Foundation (NFFF), the National Fire Service Research Agenda was originally developed in 2005, and reevaluated in 2011 and 2015 to identify research gaps that contribute to the Firefighter Life Safety Initiatives of the Everyone Goes Home Program. The Agenda was created by a diverse group of Fire Service representatives and those from supporting research agencies, spanning a wide range of experiences, with the goal of eliminating preventable line-of-duty injuries and fatalities. Each of the three reported agendas included input from a broad base of more than 100 researchers and fire service personnel and the subsequent reports built off those prior. The current (2015) research agenda found significant overlap between the seven groups focused on Community Risk Reduction; Data Management; Emergency Operations; Health and Wellness; Occupational Diseases of Firefighting; Tools and Equipment; and Wildland Firefighting. The broad agenda covers

[8] http://www.usfa.fema.gov/downloads/pdf/publications/severity_home_fires_workshop.pdf
[9] http://www.nfpa.org/news-and-research/resources/fire-protection-research-foundation/research-planning
[10] http://www.everyonegoeshome.com/wp-content/uploads/sites/2/2016/02/2015-Rearch-Agenda-Symposium-Report.pdf; http://www.everyonegoeshome.com/symposium/report2.pdf

topics in each of these categories and is recommended for review and reference for those who are applying for FP&S R&D awards in the NOFO.

- **NIST Research Roadmap for Smart Fire Fighting**[11] **-** This roadmap was constructed to identify and address high-priority measurement science research challenges, technical barriers, and related research and development gaps that hinder widespread application of Smart Fire Fighting technologies and systems to enhance building and community fire protection, making fire fighters more effective and efficient, positively influencing their safety and health, and generally supporting progress in resolving the overall fire problem. Each chapter was developed by subject matter experts from the scientific domain and fire service domain. This document provides planning for how the firefighter, local area sensor and building located sensors can work together in order to increase effectiveness and reduce risk across the spectrum of fire department functions (from inspection to response to post-fire investigation)
- **NFPA United States Fire Service Needs Assessment.** The NFPA *United States Fire Service Needs Assessment*[12] helps to identify where investment is needed in supporting local jurisdictions - particularly those in smaller communities - to attain basic levels of capabilities. In 2015, it was found that a large percentage of departments still cannot outfit each of their firefighters with self-contained breathing apparatus, radios and modern personal protective clothing. This same assessment found that, in addition to basic response capabilities, the overwhelming majority of the departments do not have wellness programs such as behavioral health and/or firefighter fitness and health.

While these assessments and agenda provide an important framework for the development of a research program to support fire and firefighter safety, there are some important limitations of each. In most cases, these documents are the output of a large gathering of individuals with broad expertise, but they are often limited to the scope of knowledge of those who are invited to the table as well as the instrument that is being utilized to collect this information. Thus, the guidance that they provide should not restrict the pathway forward in research. For example, the terms 'Cancer' and 'Behavioral Health' did not appear on the 2005 NFFF National Fire Service Research Agenda. In 2011, as the awareness in the fire service began to evolve, these phrases began to appear in a few recommendations. Both appear in multiple recommendations in the 2015 NFFF Research Agenda document and are leading topics of conversation in today's fire service. In the NFPA Needs Assessment, questions specifically regarding these concerns were added in the 2015 assessment (Behavioral Health Program; Exposure control/PPE decontamination; Monitoring air quality on fireground). However, it is important to note that the FP&S funded work from UL on fireground smoke exposure in FY2007 and behavioral health awareness study at Texas A&M in FY2010. *These initial studies have laid the groundwork for the significant research that the FP&S is currently funding in both areas, reinforcing the notion that fire service researchers are in a unique position to recognize risk and design studies to clarify the magnitude of the risk and interventions to address it effectively*.

[11] http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1191.pdf
[12] http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/the-fire-service/administration/needs-assessment

## 2. Effectiveness of the FIRE grant program in addressing the *Research* needs of the fire community

Stated bluntly, *the FIRE grant program is absolutely vital for a broad based, action oriented federal research program that is focused on the needs of firefighter community. The relatively small slice of the AFG grant programs that is allotted to the Fire Prevention & Safety (FP&S) grants provides an incredibly high impact on fire departments across the country* – increasing their effectiveness and helping them operate more safely. While other aspects of the AFG focus largely on supporting local equipment, training and staffing needs – which are all critical elements of a comprehensive local response capability – the FP&S program provides an opportunity to focus on prevention programs that can build resiliency in our communities, through local effort as well as supporting national level programs that feed to the local communities. Between FY2011 and FY2015 (last set of complete data available), a little over $170M has been awarded from this program compared to $1.5B and $1.7B in the AFG and SAFER programs. Of the limited pool of money directed to FP&S, a small portion of this money has been devoted to the Research & Development (R&D) activities ($33M). Between FY06 and FY2010, an average of nearly $10M was awarded to 11 projects each year, though only a little over $6.5M and 6 projects per year have been supported between FY2011 and FY2015.

The FP&S R&D activity is a small but focused program in that "*The goal of this Research and Development Grants Program activity is to reduce firefighter fatal and nonfatal injuries and improve firefighter safety, health, and wellness."*[13] These grants are tied directly to the voice of the fire service, as part of the Notice of Funding Opportunity (NOFO) directs the applicant to the NFFF Research Agenda. A unique aspect of these grants is that they are reviewed not only by academic subject matter experts to ensure scientific rigor, but also by a Fire Service review panel to ensure the proposed project addresses a concern of importance, can be implemented by the Fire service and has an important potential impact. In this way, the FP&S program provides a unique, broad, and relevant review of these projects in order to improve the likelihood of success, not only in the lab, but on the fireground.

Importantly, the type of occupationally focused, applied level research that has led to so much success in the AFG program is not as easily funded by other Federal agencies such as National Institutes of Health (NIH) or the National Science Foundation (NSF). Efforts to translate scientific findings into fire service policies are also unlikely to be funded through other Federal agencies, yet remains a critical aspect of the FP&S funding program.

### 2.1 Examples of FP&S supported research

There are multiple examples of successful research projects funded by FP&S R&D activity. Here, I highlight a few specific examples to describe relative impact on the fire service and the larger AFG and SAFER grant programs.

[13] https://www.fema.gov/fire-prevention-safety-grants-research-development

- **Cardiovascular** – As highlighted by the yearly NFPA reports, the leading cause of on-duty firefighter fatalities is sudden cardiovascular events. This fact has remained constant for the last several decades. In the first NFFF Research Agenda, the importance of understanding the cardiovascular implication of firefighting and developing protective interventions was broadly highlighted. Even in early technology needs assessments, physiological status monitoring (PSM) was highlighted as a critical avenue for further research. As such, funding from FP&S R&D grants has supported significant and enduring research in this area, where studies have focused on
    - Characterizing cardiac strain of firefighting including the impact of different configurations of PPE and different types of activities
    - Protective value of fitness and nutrition interventions
    - Efficacy of pharmacological interventions (aspirin, statins, Vitamin C)
    - Appropriate medical screening to detect structural heart disease that increases likelihood of sudden incapacitation and death

  Over the past 10 years, this work has been advanced by researchers at Harvard, Skidmore College, Pittsburgh, Illinois and Arizona, resulting in greater understanding of the risks firefighters face as well as viable interventions to reduce these risks. Much of this research has been translated to the fire service through NFPA health and safety standards, USFA reports, IAFF/IAFC activities such as the Wellness/Fitness Initiative (WFI) and through NVFC and NFFF channels - just to name a few.

- **Firefighter location and PSM technologies** – The first NFFF research agenda and needs analyses from Project Responder and IAB each consistently highlighted the importance of tracking and locating responders in an emergency incident and monitoring their status. This too was an area of early R&D investment by the FP&S grants, where different approaches were proposed and funded. At least one technology has successfully transitioned to a commercialized product and other projects have helped to initiate standardizable evaluation methods for location technologies. Current AFG funding is supporting a project to advance targeted technological solutions for improved firefighter safety (ECG monitoring, improved heat stress algorithms, particulate monitoring). While this topic still remains one of the highest priorities in the fire service and an important technological question, the FP&S program provided some of the earliest funding to address this concern and begin to develop a solution.
- **Firefighting tactics** – Through a series of studies led by Underwriter's Laboratories as well as projects from NYU/NIST, the American Fire Service has a greater understanding of the modern fireground environment to which we respond. Their substantial body of research has helped the fire service appreciate that temperatures in building fires using modern construction materials and polymer based furnishings are far higher than temperatures produced by legacy furnishings of natural materials. These modern fire environments also produce products of combustion that contain far more toxicants and carcinogens that may have multiple detrimental effects on the human body. Researchers have also shown that light-weight construction methods can significantly impact the time before structural collapse, changing the risk profile for firefighters and occupants alike. In

one of the broadest information sharing efforts aimed at the fire service, these research findings are constantly vetted through firefighter subject matter experts, shared through on-line and in person programs across the country.

- **Fireground staffing –** As early as 2008, a series of studies led by CFAI-Risk on fire fighter safety and deployment of resources was designed to enable fire departments and authorities having jurisdiction to make informed decisions regarding resource allocation and service using scientifically-based community risk assessment. As today's fireground and fire equipment continues to evolve, so does research to understand the strenuous nature of firefighting on the safety and health of personnel on the fireground, in particular the risk for repeated exposures and working through multiple SCBA bottles during firefighting activities (as opposed to relieving crews after 1-2 bouts of firefighting work). This knowledge helps local jurisdictions determine the relative risk of different staffing levels that can be used to support SAFER grant proposals and/or staffing strategies.
- **Musculoskeletal injuries** – Addressing some of the leading injury concerns in the Fire Service, the FP&S program has funded several projects related to musculoskeletal injuries. These studies have focused on risks on the fireground as well as the wide variety of other emergency responses that firefighters are engaged in. Specific studies have focused on the impact of PPE and fatigue from firefighting operation on ability to work and move on the fireground, development and assessment of assist devices to move medical patients/occupants out of structures and the development of exercise programs to reduce the risk for back injuries which may be encountered on the fireground, medical calls or simply calls for assistance.
- **Cancer** – The need to more fully understand the cancer concerns in the fire service initially appeared on the 2011 NFFF Research agenda and was brought into sharper focus in the 2015 document. While this topic has relatively recently appeared on the agenda, investment by the FP&S program has already provided opportunities for vigorous study. Ongoing projects are studying the exposures firefighters face on the fireground, methods to improve protection from these exposure, methods to clean firefighters and PPE after these exposure, tools to monitor particulate on the fireground as well as a broad study to evaluate exposure tracking system and create a biomarker analysis center to study epigenetic effects. While we are making rapid strides in this area, there is much more to be done.

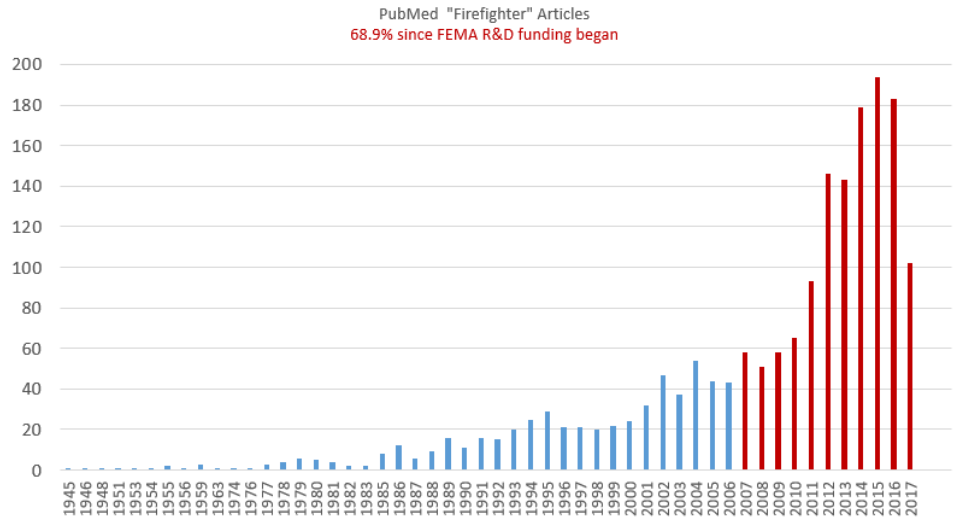
Broad multidisciplinary problems require broad multidisciplinary teams. One of the most encouraging trends in the FP&S R&D programs is the high degree of collaboration among researchers investigating health and safety concerns among firefighters. The challenges that firefighters face are often complex and overlapping, and researchers have begun to leverage modest resources to provide high impact data through large-scale, comprehensive studies. For example, a single study combining researchers in fire dynamics and tactics (UL), occupational chemical exposure (NIOSH) and cardiovascular stress (IFSI) is uncovering new information on fireground risks in a manner that would not be possible without the entire team's expertise[14].

[14] https://www.youtube.com/watch?v=uZO3GO1Nd-E

## 2.2 Impact of FP&S supported research

There are a multitude of different metrics that can be utilized to characterize the impact of a program and here I will share just a few. The FP&S and specifically funding for R&D programming has a) driven an increase in academic research focused on the firefighter, b) changed the way academic research interacts with its stakeholders to improve research to practice, c) directly influenced a wide range of policies (SOGS and SOPs) across the country from fireground tactics to support policies to purchasing decisions, and d) had broader impacts well beyond the Fire Service audience for which the work was initially targeted.

**Influx of Peer-Reviewed Scientific Research**. A simple metric of impact that scientists often point to is production of peer-reviewed scientific journal articles reporting on a specific topic. The figure below has been assembled by Dr. Sara Jahnke from Center for Fire, Rescue & EMS Health Research of the National Development & Research Institutes where she has queried the PubMed index for articles related to 'Firefighter'. While only a subset of the projects that FP&S funds would be indexed here – and not all of these are directly recipients of AFG funding - it is apparent that a significant increase in these articles began in the 2-5 year timeframe after the FP&S program began funding R&D activities in FY2005. In fact, *almost 70% of the 'Firefighter" articles located on PubMed were from after the advent of FEMA R&D funding*. The state of science has most certainly advanced in the past 10 years largely because of the availability of funds to specifically focus on this topic This increase in publication record demonstrates the willingness of the academic research community to engage important questions of health and safety for firefighters and demonstrates that the research is of high quality and is being successfully peer-reviewed. Although this rapid increase in a body of scientific literature is encouraging, it is also apparent that the research base supporting the fire service lags considerably behind national efforts to provide scientific support for our military troops who also perform mission critical work and require strong science to support performance in the most effective way - that protects the health and safety of personnel. Given the critical work that firefighters do every day in protecting their communities, and the homeland, it is critical that we continue to invest in science to support the fire service.




*2017 data is for the partial year only

**Engagement between firefighters and researchers**. Along with the impressive record of increasing peer review publications, *innovations in the way in which the FP&S program reviews and prioritizes research has improved the delivery of findings from scientists to the fire service stakeholders.* For example, recent studies at the University of Illinois - a Research 1 university – involve collaboration with top faculty from across campus, different academic institutions, and fire service partners. In the past, we would get the funding, design the study, collect data, analyze data, publish academic papers, then report to the fire service. In some cases there would be 2-5 years from award to the time that the fire service would learn of the study. Over the past 3 years, we have increased on focus on communicating with the fire service through social media and fire service media partners. We are holding webinars before data is collected to get the fire service engaged and informed as to why we are doing this work. In some cases, this interaction with fire service stakeholders has even allowed us to modify our projects to add measurements on victim tenability or flame retardant exposure based on feedback from these early outreach efforts. Media outlets such as *Fire Engineering* and *Firehouse* broadcast live from our location during and after data collection to provide a behind the scenes view of what is happening to make science more acceptable and digestible to our occupation. Interim reports are produced in a manner that does not interfere with academic peer- reviewed publication. Academic papers are open access and tool kits are developed to translate the findings into tactical and policy considerations for the lay firefighter and fire officer. This fundamental shift was driven by the requirements of the FP&S program that were driven by the fire service themselves.

**Research to practice**. *The FP&S research has directly and thoughtfully impacted practice in fire departments across the country*. Previous research has found its way to practice in a multitude of ways. The dedicated and thorough tactics research conducted by UL has led to significant rewrites of standard operating procedures across the country, maybe nowhere more visible than in the largest fire department in the country – FDNY. Separate research at Illinois on fireground rehabilitation and decon practices has continued to inform critical fireground policies for firefighter health and safety. National organizations such as IAFF, IAFC, NVFC, NFFF and others have utilized data and information collected from R&D grants to develop national policy and information sharing for their stakeholders under the FP&S National Programs. A multitude of NFPA standards have been influenced and directly updated as a result of the research conducted as part of this program. Specific examples can be cited, such as the FP&S funded research led by the NYU/NIST team at Governors Island resulting in FDNY applying for a subsequent AFG grant to have positive pressure ventilation (PPV) fans on every engine in the city. Research on the biomechanical impact of larger SCBA sizes has informed purchasing agents as they spec and write AFG grants for new breathing apparatus. And very recent data on fireground chemical exposures has spurned industry to introduce new firefighting hoods and decontamination equipment (among many other technologies under development) over the last year that is likely to continue the loop of FP&S supported research informing AFG supported purchases.

**Broader impacts**. Importantly, *the benefits of the research supported AFG FP&S R&D grants often extend beyond the fire service organization that are the original target*. For example:

- Cardiovascular research is of interest to the large CV community as the body's response to the intense strain imposed by firefighting is not easily replicated in lab or other settings. Exercise physiologist and cardiologists are keenly interested in these results as they extend the understanding of human cardiovascular physiology – and means to prevent cardiac mortality and morbidity – continues to develop (*American Journal of Cardiology; Circulation*)
- Heat stress research with the fire service has led to collaborations with the military to improved predictions of core temperature during various activities of interest to both populations (*Ergonomics*)
- Detailed study of fireground chemical exposures has allowed improved understanding of pathway that volatile organic compounds such as benzene (which may be encountered in other occupations) can enter the body and be metabolized (*Journal of Occupational and Environmental Hygiene*).
- Public service messages focused on the value of closed doors as part of a comprehensive home fire safety program were developed from a study of firefighter tactics. While focusing on fireground operations, researchers at UL found significantly increased survivability in rooms with closed interior doors, a finding that has been shared broadly through the internet and social media(*Fire Technology*)[15]
- Studies to improve firefighting tactical decisions with regards to water application have recently resulted in new measurement techniques for high temperature moisture and products of combustion (HCN) that have broader application in combustion diagnostics as well as ex vivo porcine model that is providing new insights into skin burn risk for general population.

### 3. Recommended improvements to the *Research* grant programs

While the FP&S program has been incredibly successful in supporting the evolving concerns and needs of the fire service, there are some challenges that, if addressed, could lead to even greater reach of the program.

- As with many programs, challenges with resourcing to an appropriate level exist. Considering the high benefit to cost ratio, *it would be appropriate to restore funding and award rates (at a minimum) to the levels in FY06-FY10*. This modest increase in funding and subsequent increase in proposals funded would restore the broad, multidisciplinary scope to the research organizations that participate. When the FP&S program began, many of the projects were from a single organization. After years of cross pollination at mid-year meetings, these individuals have developed into multidisciplinary and trans-disciplinary teams that continue to work together even outside of the FP&S. As individual researchers and institutions have invested themselves in a research focus to support the fire service, we need to have adequate levels of funding to fund well-designed studies that support the mission of the AFG program.

[15] https://closeyourdoor.org/

- *Allow longer duration funding mechanisms for longitudinal projects, similar to an R01 mechanism that provides funding for 5 years, perhaps with opportunity for 5 more*, allows research to use the strongest research designs (longitidual studies) to address pressing health concerns (cancer, behavioral health, vascular changes, progression of structural heart disease, etc). Such an extension of funding would allow even greater scientific rigor and would further increase the credibility of the program and the impact it has on firefighter health and safety.
- *Funding and visibility for dedicated exploratory projects can be increased to support promising work from outside of the existing fire service research enterprise that may have future impacts*. Much as initial smoke exposure and behavioral health projects were funded by DHS FP&S prior to their appearance on "needs assessments" and the broad awareness that currently exist within the fire service, money should be dedicated to initiating studies that do not necessarily impact the current research agenda or needs analysis if the science and logic supports its study. This is potentially a high impact area as it leverages the knowledge of the research community in serving the fire service.
- *Funding for Centers of Excellence through the FP&S program to create a flexible, trans-disciplinary group of researchers who are dedicated to working with the Fire Service would be a natural extension of the interdisciplinary teams that are currently coalescing* to address large complex and interrelated problems in the fire service. A center, if appropriately resourced and supported may be the most cost effective and high impact way to leverage these collaborations
- While there are certainly other factors to be considered when releasing the NOFO and accepting application, *a repeatable and consistent timeline would greatly benefit the applicants and support system for this program*. This is particularly important for academic applicants who may need to recruit students to work on these relatively short term activities.

In summary, the Fire Prevention & Safety program (and particularly the R&D activity) is a relatively small component of the larger FIRE grant program, yet provides wide-ranging and important impact. that improves the effectiveness of the fire service and enhances the health and safety of the firefighters. Of the total grant program, the FP&S has the broadest national level impact, informing the national conversation through major national organizations (IAFF, IAFC, NVFC, USFA, NFFF) and by supporting local fire departments through empowering improved purchasing decisions (in some cases for AFG grants); better understanding of manpower requirements for varying tasks (supporting SAFER grants); allowing for the development of evidence-based policies, procedures and practices.; and providing critical information and education regarding the health risks that firefighters face and mitigation strategies they can adopt to lessen those risks.