2015 National Fire Service Research Agenda

Recommendations Report

January 2016

Executive Summary

The 2015 National Fire Service Research Agenda Symposium (RAS) was held November 15-18, 2015 in Arlington, Virginia. Firefighter Life Safety Initiative #7 calls for the creation and maintenance of a fire service research agenda. To that end, the National Fallen Firefighters Foundation has previously hosted two research agenda symposiums in 2005 and 2011.

Although the publication of a new Fire Service Research Agenda causes great excitement in the academic and research community, the broader fire service often has very little interface with it, and may subsequently lack understanding of its true impact. They are often unaware that virtually every research project conducted by, or on behalf of the fire service, has its roots in the Research Agenda. In fact, demonstrating a project's connection to its recommendations is often a gateway to grant funding for researchers.

This use of the Research Agenda as a screening tool by grantors reflects the meticulous work by those who are invited to participate and offer their insights concerning where research dollars must be spent. The researchers and fire service partners who take part in its development bring to the table untold hours of thought and experience regarding their topics. The recommendations found in this new iteration of the Research Agenda were developed with input from the nation's most highly trained and informed subject matter experts, who through education and experience, understand what must be accomplished to keep firefighters safe, fit, healthy and effective.

The 2015 Research Agenda may not look familiar to those who have used previous editions. Whereas the 2005 and 2011 Research Agenda Reports were primarily lists of the breakout group recommendations, this time the process by which the recommendations made it to the final report differed significantly. Instead of the breakout groups having the final decision, a second layer of oversight, in the form of a jury, was used to vet and refine the recommendations. Composed of selected experts from the fire service, the jury required representatives of the breakout groups to present and defend their recommendations before the assembled body. This process produced lively and edgy presentations and generated demanding questions from both the jury and audience.

At the conclusion of the formal meetings, the jury met in private to review and discuss all of the proposed recommendations. This process resulted in the Research Agenda contained in this document. Instead of the 54 recommendations being lumped together by breakout group topics, they are instead bundled into three thematic groups—data collection and data analysis projects, problem or program analysis and evaluation projects, and research to practice projects. So, while upon first glance this document may be more challenging than previous versions, we expect it will be infinitely more useful to the research community, and to the fire service as a whole.

Thank you to the National Institute of Standards and Technology for their generous support of the symposium. I would also like thank the researchers and attendees who generously contributed their time and talent to this important effort. In the end, they were supportive of this new methodology, and evaluated this experience as extremely helpful to the research community. We are also very grateful to the jurors, especially Dr. John Granito and Deputy Chief John Tippett, who expertly shepherded the deliberations. The jury process was a great success, in large part due to their commitment and leadership.

Finally, to the research community, I would like to emphasize the positive impact this Research Agenda will have on our industry. At this point, we continue to struggle with achieving consistent reductions in line-of-duty death rates and injury rates among firefighters. It is my belief that the Research Agenda is key to reducing firefighter injuries and fatalities in the future. I ask every fire service research professional to take the time to become familiar with this document and commit to successfully addressing its recommendations. The progress we make through research is so critical – and working together we can ensure that our individual and collective efforts are not in vain.

Chief Dennis Compton

Chairman, Board of Directors
National Fallen Firefighters Foundation

Visit www.everyonegoeshome.com/resources/research-symposium for more information on previous National Fire Service Research Symposium reports. For information on the 1999 Fire Research Needs Workshop Proceedings, visit http://fire.nist.gov/bfrlpubs/fire00/art038.html.

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Table of Contents

Executive Summary ii
Recommendations Process 5
Phase One: Breakout Sessions 5
Phase Two: Jury Deliberations 6
Phase Three: Post-Symposium Jury Review and Final Review 8
Key to Recommendations 9
Themes 9
Priority Levels 9
Topics 10
Recommendations 12
NFFF Excellence in Research Award 14
Appendix A: 16 Firefighter Life Safety Initiatives 24
Appendix B: 2015 Recommendations 25
Appendix C: Participants and their Organizations 29
Appendix D: 2015 Recommendations – Apparatus 32
Appendix E: 2015 Recommendations – Community Risk Reduction 33
Appendix F: 2015 Recommendations – Data 34
Appendix G: 2015 Recommendations – Economic Impact 38
Appendix H: 2015 Recommendations – Effectiveness/Impact 40
Appendix I: 2015 Recommendations – Emergency Operations 43
Appendix J: 2015 Recommendations – Greater Good 45
Appendix K: 2015 Recommendations – Health and Wellness 48
Appendix L: 2015 Recommendations – Messaging 50
Appendix M: 2015 Recommendations – Occupational Diseases 52
Appendix N: 2015 Recommendations – Personal Protective Equipment 54
Appendix O: 2015 Recommendations – Technology 55
Appendix P: 2015 Recommendations – Tools and Equipment 58
Appendix Q: 2015 Recommendations – Wildland Firefighting/Wildland-Urban Interface 60

Recommendations Process

The National Fire Service Research Agenda is an assembly of individual recommendations for research projects that span a wide range of subjects. These recommendations were developed by the more than 100 individuals who participated in the 2015 National Fire Service Research Agenda Symposium. The recommendations are intended to address the primary needs and priorities of the fire service. A three-phased process was used in the creation of the final recommendations.

Phase One: Breakout Sessions

Symposium attendees were divided into seven breakout group structured to focus on different areas of interest and expertise. Each group was asked to develop a series of recommendations for future research projects within their assigned subject areas.

The assignments for the breakout sessions were defined as:

Community Risk Reduction

This group discussed research needs related to public education, fire prevention, codes and code enforcement, residential sprinklers and additional measures to reduce vulnerability fire deaths, injuries and property losses.

Data Management

This group addressed issues related to the collection, management and dissemination of accurate, timely, standardized and useful data related to fire service research needs.

Emergency Operations

This group was charged with identifying research needs related to the full range of emergency operations, including fire suppression, technical rescue, fire-based EMS and all other aspects of fire service operations.

Health and Wellness

This group addressed research needs within the areas of overall health and wellness, including medical and physical fitness, stress management, post-traumatic stress, suicide prevention, psychological assistance, tobacco cessation and nutrition.

Occupational Diseases of Firefighting

The primary focus of this group was on research related to occupational illnesses, particularly cardiovascular and cancer-related diseases and other conditions that have particular impact on the fire service.

Tools and Equipment

This group considered research needs related to apparatus and equipment, personal protective ensembles, communications systems, technology applications and all related subject matter.

Wildland Firefighting and Wildland-Urban Interface

This group addressed the research needs of the wildland and wildland-urban interface community including firefighting tactics, tools, equipment and gear.

Two facilitators were assigned to work with each group, supported by a scribe to capture the recommendations. As a starting point, the facilitators were provided with the recommendations from the 2011 National Fire Service Research Agenda Symposium that related to their assigned subject areas. The groups considered each of these recommendations, in order to determine which topics are still relevant and should be retained, updated or revised for inclusion in the 2015 Research Agenda. The groups were then asked to identify additional and emerging topics for possible inclusion as new research priorities.

Once the group identified specific research topics, they were asked to prioritize each of their recommendations within one of three categories: critical/essential, important and emerging.

The prioritization criteria used to categorize the recommendations was not pre-defined. These rankings were intended to be a preliminary indication of the relative priorities that each group felt was appropriate within their specific domain. The final prioritization would be accomplished by the jury after a detailed review of all the recommendations.

In a general session at the conclusion of the Symposium, each group presented their group's recommendations to the jury and other attendees. Jury members were able to question the presenters on the recommendations, and attendees had an opportunity to provide comments and observations. The recommendations from every group were provided to the jury in hard-copy and electronic form for use during jury deliberations.

Phase Two: Jury Deliberations

The jury was charged with reviewing and validating the recommendations, defining the prioritization system that would be applied to the recommendations and determining the final organization of recommendations within the Research Agenda. The process began with a review of each recommendation and the prioritization determined by the breakout session attendees.

Review of Recommendations

The jury determined that several recommendations submitted by different groups could be combined or consolidated because of duplication. The jury also made minor edits to some recommendation statements, rewording several of the recommendations to more clearly express their intent as research projects. The jury also decided that one new recommendation should be added to address a subject mentioned by several groups in the discussion phase, but not presented as a specific recommendation —"Conduct a study of the life span of personal protective equipment."

After the initial review, the jury determined it necessary to expand the original seven subject areas to include the following additional topic areas:

- Apparatus
- Economic impact
- Effectiveness/impact assessment
- Greater good
- Messaging
- Personal protective equipment
- Technology

The jury then classified each recommendation under one of these 14 topics. There was much discussion on how to categorize an individual recommendation that was relevant to multiple topics. For example, "Develop a centralized data warehouse and common data elements to facilitate research related to wildland firefighting" could be classified under the data topic or the wildland firefighting/wildland-urban interface topic. (Note: A solution to this issue was determined in Phase Three of the recommendations process.)

Review of Recommendation Priority Levels

After refining the individual recommendations, the jury discussed ways to standardize and more clearly define the preliminary prioritization scale so that it could be applied consistently across the full list of research project recommendations. Throughout deliberations, the jury acknowledged that prioritization of recommendations was an inherently subjective process. However, consensus was still beneficial to prioritize the recommendations due to the limited resources available for this type of research.

Jury members discussed at great length how to measure or define the potential impact of individual research efforts that span a very broad spectrum. Using the original scale of critical/essential, important or emerging, the jury acknowledged that each recommendation could be considered critical and essential to reducing injuries and fatalities. Thus the jury determined prioritization to be articulated as Category 1, Category 2 and Category 3. (Note: These categories were further defined in Phase Three of the recommendations process.)

Phase Three: Post-Symposium Jury Review and Final Review

Following the jury deliberations, a final editing team was charged with refining the material, based on the jury's determinations and instructions, in order to produce a deliverable document. This effort involved editorial revisions to the wording of the recommendation statements, application of the jury notes and comments related to each recommendation and the organization of the recommendations into a logical system for final presentation.

The Category 1, Category 2 and Category 3 priority levels were further refined as high, medium and low. It is important to note again that both in the initial jury deliberations and during the review process, the jury deemed every recommendation provided by the breakout session attendees to be a critical research that warrants funding.

It was also determined that the recommendations should be organized in a manner that expresses the interdisciplinary nature of research in the fire service. This was intended to demonstrate how research directed toward a specific subject could require input from multiple areas, and could in turn potentially impact multiple areas.

The recommendations were then organized into three predominant themes defined as:

- Data collection and data analysis projects;
- Problem or program analysis and evaluation projects; and
- Projects that could be described as research to practice initiatives.

Key to Recommendations

The final recommendations from the 2015 National Fire Service Research Agenda Symposium include both newly created recommendations and revisions of recommendations from the 2011 National Fire Service Research Agenda Symposium. Each recommendation is categorized with a theme, a priority level and related topic(s). Appendix B lists the 54 final recommendations.

Themes

Each recommendation was grouped into one of three themes. If a recommendation overlapped several themes, one prevailing theme was selected. The themes were determined post-symposium, specifically for use in this report. The themes are:

> Data Collection and Data Analysis Projects: These recommendations generally focus on developing new foundations of research or expanding existing data and research.
>
> Problem or Program Analysis and Evaluation Projects: These recommendations address assessing and improving existing efforts related to firefighter safety. Some of these recommendations include the need for additional data and information collection as a component of the analysis and evaluation.
>
> Research to Practice Projects: These recommendations are related to targeted efforts to translate research findings into practical applications or technologies for use at the operational level.

Priority Levels

Each recommendation was assigned one of three priority levels. The priority levels were determined during the breakout session discussions and revaluated during jury deliberations. The priority levels are:

> High Priority: These recommendations have a significant impact on firefighter survivability because they relate to mission-critical job requirements. Research related to these recommendations is of the highest demonstrated priority.
>
> Medium Priority: These recommendations have an important impact on firefighter safety and survivability and may support and reinforce existing efforts to reduce risks to personnel. Research on these recommendations is of a secondary priority.
>
> Low Priority: These recommendations have an impact on firefighter health and safety. Research on these recommendations is needed and should be supported due to their often emerging nature.

Topics

Each recommendation was identified with topic(s) of interest. If a recommendation overlapped several topics, multiple topics were selected. The topics are a combination of breakout session subjects, jury deliberation categorization and post-symposium analysis. Icons represent each topic on the recommendation charts. The definitions of these topics are not formal definitions but are for general use and common purpose. The topics are identified with an icon or several icons per recommendation to illustrate that many of the recommendations are multi-disciplinary and cross several domains. The Appendix includes recommendations categorized by each topic.

Apparatus: These recommendations are for emergency vehicles or aircraft.

Community Risk Reduction: These recommendations include efforts to decrease the risk of civilian fatalities, injuries and property loss in addition to having a potential effect on firefighter health and safety.

Data: These recommendations include strategically gathering information.

Economic Impact: These recommendations examine the cost/benefit ratio of existing efforts.

Effectiveness/Impact: These recommendations aim to determine if existing efforts have made or will make an impact on intended results.

Emergency Operations: These recommendations are related to preparing, preventing and responding to emergencies.

Greater Good: These recommendations are important for the fire service community and the public at large.

Health and Wellness: These recommendations include efforts related to improving the physical and mental resilience of the fire service community.

Messaging: These recommendations are for outreach efforts to either fire service personnel or the communities in which they serve.

Occupational Diseases: These recommendations focus on illnesses, short term or chronic, and disorders which may develop due to exposures in the workplace.

Personal Protective Equipment: These recommendations involve research related to the gear worn by firefighters including coat, pants, helmets, gloves, SCBA, boots etc.

Technology: These recommendations encompass devices or concepts designed to offer a solution to a problem.

Tools and Equipment: These recommendations support improvements to the tangible resources used by firefighters.

Wildland Firefighting/Wildland-Urban Interface: Wildland recommendations focus on undeveloped land. Wildland-Urban Interface recommendations are for areas where undeveloped land abuts developed land.

Recommendations

Theme A: Data Collection and Data Analysis Projects

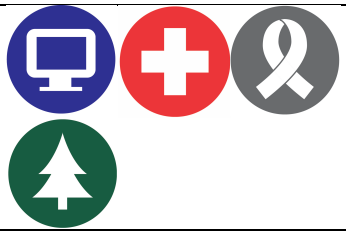
High Priority Recommendations

	RECOMMENDATIONS	TOPICS
#1	Conduct research directed toward identifying those individuals within the fire service who are at a higher risk for specific occupational injury/illness/disease.	
#2	Continue progress toward the development and refinement of enhanced data systems (such as N-FORS) across all fire service domains.	
#3	Develop a centralized data warehouse and common data elements to facilitate research related to wildland firefighting.	
#4	Develop a unified national database with common definitions on fire service fatalities, injuries and occupational illnesses.	
#5	Evaluate behavior modification strategies that will lead to lasting cultural changes resulting in improvements in data collection and use.	

#6	Identify and develop methods to capture operational data on fireground performance, mental resiliency, effective communications and operational benchmarks.	
#7	Identify and make use of traditional and non-traditional data to supplement, update and enhance fire service programs, including fire suppression and emergency operations, public education, fire prevention and community risk reduction efforts.	
#8	Improve local data collection in order to positively impact efficient service delivery, professional development and organizational health.	

Medium Priority Recommendations

	RECOMMENDATIONS	TOPICS
#9	Determine the incidence and frequency of occupational diseases/illness/injury/conditions in underrepresented groups and those with unique exposures.	
#10	Establish a center for best practices for data collection and analysis. Identify and catalog data sources and technology formats that are relevant and beneficial for the fire service.	

#11	Research total worker health of the wildland firefighter population to improve health and wellness.	

Low Priority Recommendations

	RECOMMENDATIONS	TOPICS
#12	Create a searchable database of community risk reduction programs that have been identified as best practices in communities and/or states.	

NFFF Excellence in Research Award

On the evening of November 16, 2015, Dr. Thomas Hales was awarded the inaugural *NFFF Excellence in Research Award*. The presentation was made on behalf of the National Fallen Firefighters Foundation by Chief Dennis Compton, Chair of the NFFF Board of Directors.

Dr. Hales is a senior medical epidemiologist with the CDC – NIOSH. He received his bachelor's degree from Stanford University, holds a medical degree from Case Western Reserve University and earned his Master of Public Health degree from the University of California – Berkeley. He is board certified in internal medicine and occupational/environmental medicine. As a member of CDC's emergency response team he responded to the anthrax attacks at the World Trade Center, Hurricane Katrina in New Orleans and the tsunami in Southeast Asia. For the past 10 years he has been the Team Leader of the NIOSH Fire Fighter Program – Cardiovascular Component. For the past 8 years he has been a member of the NFPA Technical Committee on Fire Service Occupational Safety. Dr. Hales was selected for this award because he is a steady and guiding influence on health and wellness in the fire service.

The NFFF will announce nomination periods for the Excellence in Research Award on the NFFF website, www. firehero.org.

Theme B: Problem or Program Analysis and Evaluation Projects

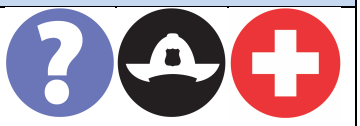
High Priority Recommendations

	RECOMMENDATIONS	TOPICS
#13	Assess the effectiveness of risk reduction messages in successfully changing targeted behaviors.	
#14	Assess the reliability and performance characteristics of alternative smoke alarm technologies.	
#15	Conduct a cost/benefit analysis of investing in fire department occupational health and safety programs, including identification of best practices and methods to institute such programs.	
#16	Conduct a study of the life span of PPE.	
#17	Conduct research based on fire dynamics to identify best practices at the strategic, tactical and task levels for firefighting operations in new and existing commercial and residential structures. The research should include the creation of on-scene risk assessment tools based on specific fire factors to assist company officers and incident commanders.	
#18	Conduct research directed toward identifying and overcoming barriers to the implementation of tobacco cessation programs and the elimination of all forms of tobacco and nicotine use (e.g. cigarettes, smokeless tobacco, e-cigarettes, other vape products). Conduct studies related to alcohol abuse, misuse and abuse of prescription drugs and illicit drugs.	

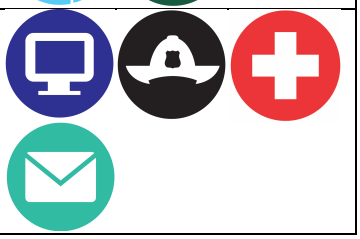
#19	Conduct research on enhanced dermal protection provided by firefighter structural protective clothing, particularly as it relates to reducing exposures to known and suspected carcinogens.	
#20	Conduct research on how science can improve wildland firefighting training, tactics and response to reduce fatalities, injuries and unintended outcomes.	
#21	Continue research into operational practices directed toward more effective tactics, improvements in firefighter safety and victim survivability and reductions in property losses. These studies should specifically address staffing and deployment, fire dynamics research and victim survivability. The focus should include high-rise residential and commercial buildings, private dwellings, multiple unit residential occupancies, strip malls, taxpayer buildings and warehouses.	
#22	Continue research on firefighter health, injury and diseases related to chronic and repeated exposures to the risks of emergency incidents and the fire service work environment. The research should encompass all disciplines including wildland and wildland-urban interface.	
#23	Continue research on firefighter health, injury and diseases related to the risks of acute exposures that may result from emergency incidents.	

#24	Determine the efficacy/effectiveness of interventions/programs/systems designed to decrease disease/exposure/injury/death and increase medical evaluations, occupational health and surveillance. The research should include under-researched populations within the fire service and include a focus on reproductive, maternal and child health issues, cardiovascular risk factors, injuries and cancer.	
#25	Identify respiratory contaminants and determine the potential adverse health outcomes associated with wildland and wildland-urban interface fire operations. Also, determine the adequate respiratory protection for wildland firefighters.	
#26	Identify, develop and refine evidence-based tools and approaches for behavioral health screening, assessment and intervention.	
#27	Research the impact of communication failures with portable radio systems and devices as a contributing factor in firefighter injuries and fatalities. Address alternative radio system configurations to ensure reliable in-building radio communications. Also, examine potential improvements in radio construction, ergonomics and the ability to interface portable radios with other technologies to track firefighters in the fire environment.	

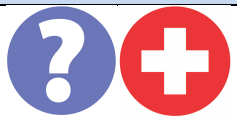
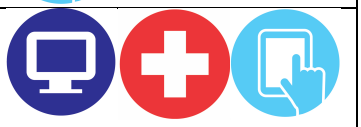
Medium Priority Recommendations

	RECOMMENDATIONS	TOPICS
#28	Assess substance misuse and abuse in the fire service (including, but not limited to alcohol, prescription drugs and illicit drugs). Focus research on the identification of effective prevention efforts, interventions and rehabilitation strategies.	
#29	Assess the effectiveness of the adoption of codes and standards in reducing the incidence and impact of fires by comparing results in locales that adopted codes and those that did not.	
#30	Assess the impact of current fire dynamics research on the health of fire investigators.	
#31	Assess the impact/influence of the adoption/enforcement of codes on the economic impact of wildland-urban interface fires. Consider the impact on both wildland to urban and urban to wildland fire transitions. Examine the impact on both fire ignitions and losses.	
#32	Assess the overall effectiveness of fire and injury reduction programs on the accomplishment of targeted reductions in fatalities, injuries and property loss.	
#33	Conduct research on cleaning methods for firefighter protective clothing, including potential impacts on the protective properties and useful life of the clothing, and determining effectiveness of removal of suspected carcinogens and other contaminants.	

#34	Conduct research on the translation, dissemination and messaging of current knowledge and best practices related to health and wellness programs, including physical fitness, health maintenance, nutrition and annual medical evaluations.	
#35	Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds.	
#36	Determine the most effective implementation methods to institute occupational health programs.	
#37	Develop methods to evaluate and quantify the direct and indirect economic impacts of fire service response and operations on property, people and the environment.	
#38	Evaluate the impact of modern and evolving building technology (i.e. green buildings, solar and battery storage systems) on fire service operations. Create a knowledge base for incident commanders, company officers and firefighters to support operational safely and proficiently.	

#39	Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway).	
#40	Research the effectiveness of alternative learning mechanisms in order to identify and develop the best firefighter training delivery system(s) for strategic, tactical and task level operations.	
#41	Conduct research into establishing safe and reliable aircraft operations in the wildland-urban interface.	
#42	Conduct research on the risks and/or benefits of supplements (e.g. nutritional supplements, sports energy drinks, creatine and testesterone).	

Low Priority Recommendations

	RECOMMENDATIONS	TOPICS
#43	Conduct research on the efficacy and effectiveness of health and wellness programs for individuals and organizations. Focus on programs directed toward preventive behavioral change. The research areas should include fitness, nutrition, hydration, sleep and hygiene.	
#44	Measure the fire growth rate in new homes which are built to modern energy codes and specifications and furnished with contemporary fire loads. Simulate and evaluate escape times based on the realistic capabilities of individuals.	
#45	Conduct research on the effectiveness of alternative implementation strategies and policies for health and wellness programs.	
#46	Develop a physical fitness risk assessment tool for wildland firefighters.	

Theme C: Research to Practice Projects

High Priority Recommendations

	RECOMMENDATIONS	TOPICS
#47	Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks.	
#48	Research the development of technology, tactics and response standards in the wildland-urban interface. Include PPE requirements for all responders.	

Medium Priority Recommendations

	RECOMMENDATIONS	TOPICS
#49	Align research projects with strategies to enhance the benefits of the research. Identify data and technology formats that are most beneficial to the fire service.	
#50	Conduct research to make improvements in the survivability of fire apparatus crashes. Conduct research related to anthropometric and ergonomic challenges in fire apparatus construction and arrangements that lead to frequent head and musculoskeletal injuries.	

#51	Develop a user-friendly technological accountability system for use on the fireground.	
#52	Evaluate existing ballistic protection options (including helmets) for firefighters and EMS responders. As indicated by findings, develop new options.	

Low Priority Recommendations

	RECOMMENDATIONS	TOPICS
#53	Determine the necessary components to be included in the educational process for incident commanders, taking into account risk management, tactics, operational concerns and an acceptable knowledge base.	
#54	Research the application of unmanned aerial vehicles for the fire service.	

Appendix A: 16 Firefighter Life Safety Initiatives

FLSI #1	Define and advocate the need for a cultural change within the fire service relating to safety; incorporating leadership, management, supervision, accountability and personal responsibility.
FLSI #2	Enhance the personal and organizational accountability for health and safety throughout the fire service.
FLSI #3	Focus greater attention on the integration of risk management with incident management at all levels, including strategic, tactical and planning responsibilities.
FLSI #4	All firefighters must be empowered to stop unsafe practices.
FLSI #5	Develop and implement national standards for training, qualifications, and certification (including regular recertification) that are equally applicable to all firefighters based on the duties they are expected to perform.
FLSI #6	Develop and implement national medical and physical fitness standards that are equally applicable to all firefighters, based on the duties they are expected to perform.
FLSI #7	Create a national research agenda and data collection system that relates to the initiatives.
FLSI #8	Utilize available technology wherever it can produce higher levels of health and safety.
FLSI #9	Thoroughly investigate all firefighter fatalities, injuries and near misses.
FLSI #10	Grant programs should support the implementation of safe practices and/or mandate safe practices as an eligibility requirement.
FLSI #11	National standards for emergency response policies and procedures should be developed and championed.
FLSI #12	National protocols for response to violent incidents should be developed and championed.
FLSI #13	Firefighters and their families must have access to counseling and psychological support.
FLSI #14	Public education must receive more resources and be championed as a critical fire and life safety program.
FLSI #15	Advocacy must be strengthened for the enforcement of codes and the installation of home fire sprinklers.
FLSI #16	Safety must be a primary consideration in the design of apparatus and equipment.

Appendix B: 2015 Recommendations

	RECOMMENDATIONS
#1	Conduct research directed toward identifying those individuals within the fire service who are at a higher risk for specific occupational injury/illness/disease.
#2	Continue progress toward the development and refinement of enhanced data systems (such as N-FORS) across all fire service domains.
#3	Develop a centralized data warehouse and common data elements to facilitate research related to wildland firefighting.
#4	Develop a unified national database with common definitions on fire service fatalities, injuries and occupational illnesses.
#5	Evaluate behavior modification strategies that will lead to lasting cultural changes resulting in improvements in data collection and use.
#6	Identify and develop methods to capture operational data on fireground performance, mental resiliency, effective communications and operational benchmarks.
#7	Identify and make use of traditional and non-traditional data to supplement, update and enhance fire service programs, including fire suppression and emergency operations, public education, fire prevention and community risk reduction efforts.
#8	Improve local data collection in order to positively impact efficient service delivery, professional development and organizational health.
#9	Determine the incidence and frequency of occupational diseases/illness/injury/conditions in underrepresented groups and those with unique exposures.
#10	Establish a center for best practices for data collection and analysis. Identify and catalog data sources and technology formats that are relevant and beneficial for the fire service.
#11	Research total worker health of the wildland firefighter population to improve health and wellness.
#12	Create a searchable database of community risk reduction programs that have been identified as best practices in communities and/or states.
#13	Assess the effectiveness of risk reduction messages in successfully changing targeted behaviors.
#14	Assess the reliability and performance characteristics of alternative smoke alarm technologies.
#15	Conduct a cost/benefit analysis of investing in fire department occupational health and safety programs, including identification of best practices and methods to institute such programs.
#16	Conduct a study of the life span of PPE.
#17	Conduct research based on fire dynamics to identify best practices at the strategic, tactical and task levels for firefighting operations in new and existing commercial and

	residential structures. The research should include the creation of on-scene risk assessment tools based on specific fire factors to assist company officers and incident commanders.
#18	Conduct research directed toward identifying and overcoming barriers to the implementation of tobacco cessation programs and the elimination of all forms of tobacco and nicotine use (e.g. cigarettes, smokeless tobacco, e-cigarettes, other vape products). Conduct studies related to alcohol abuse, misuse and abuse of prescription drugs and illicit drugs.
#19	Conduct research on enhanced dermal protection provided by firefighter structural protective clothing, particularly as it relates to reducing exposures to known and suspected carcinogens.
#20	Conduct research on how science can improve wildland firefighting training, tactics and response to reduce fatalities, injuries and unintended outcomes.
#21	Continue research into operational practices directed toward more effective tactics, improvements in firefighter safety and victim survivability and reductions in property losses. These studies should specifically address staffing and deployment, fire dynamics research and victim survivability. The focus should include high-rise residential and commercial buildings, private dwellings, multiple unit residential occupancies, strip malls, taxpayer buildings and warehouses.
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#23	Continue research on firefighter health, injury and diseases related to the risks of acute exposures that may result from emergency incidents.
#24	Determine the efficacy/effectiveness of interventions/programs/systems designed to decrease disease/exposure/injury/death and increase medical evaluations, occupational health and surveillance. The research should include under-researched populations within the fire service and include a focus on reproductive, maternal and child health issues, cardiovascular risk factors, injuries and cancer.
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#27	Research the impact of communication failures with portable radio systems and devices as a contributing factor in firefighter injuries and fatalities. Address alternative radio system configurations to ensure reliable in-building radio communications. Also, examine potential improvements in radio construction, ergonomics and the ability to interface portable radios with other technologies to track firefighters in the fire environment.

#28	Assess substance misuse and abuse in the fire service (including, but not limited to alcohol, prescription drugs and illicit drugs). Focus research on the identification of effective prevention efforts, interventions and rehabilitation strategies.
#29	Assess the effectiveness of the adoption of codes and standards in reducing the incidence and impact of fires by comparing results in locales that adopted codes and those that did not.
#30	Assess the impact of current fire dynamics research on the health of fire investigators.
#31	Assess the impact/influence of the adoption/enforcement of codes on the economic impact of wildland-urban interface fires. Consider the impact on both wildland to urban and urban to wildland fire transitions. Examine the impact on both fire ignitions and losses.
#32	Assess the overall effectiveness of fire and injury reduction programs on the accomplishment of targeted reductions in fatalities, injuries and property loss.
#33	Conduct research on cleaning methods for firefighter protective clothing, including potential impacts on the protective properties and useful life of the clothing, and determining effectiveness of removal of suspected carcinogens and other contaminants.
#34	Conduct research on the translation, dissemination and messaging of current knowledge and best practices related to health and wellness programs, including physical fitness, health maintenance, nutrition and annual medical evaluations.
#35	Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds.
#36	Determine the most effective implementation methods to institute occupational health programs.
#37	Develop methods to evaluate and quantify the direct and indirect economic impacts of fire service response and operations on property, people and the environment.
#38	Evaluate the impact of modern and evolving building technology (i.e. green buildings, solar and battery storage systems) on fire service operations. Create a knowledge base for incident commanders, company officers and firefighters to support operational safely and proficiently.
#39	Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway).
#40	Research the effectiveness of alternative learning mechanisms in order to identify and develop the best firefighter training delivery system(s) for strategic, tactical and task level operations.
#41	Conduct research into establishing safe and reliable aircraft operations in the wildland-urban interface.
#42	Conduct research on the risks and/or benefits of supplements (e.g. nutritional supplements, sports energy drinks, creatine and testesterone).
#43	Conduct research on the efficacy and effectiveness of health and wellness programs for individuals and organizations. Focus on programs directed toward preventive behavioral change. The research areas should include fitness, nutrition, hydration, sleep and hygiene.

#44	Measure the fire growth rate in new homes which are built to modern energy codes and specifications and furnished with contemporary fire loads. Simulate and evaluate escape times based on the realistic capabilities of individuals.
#45	Conduct research on the effectiveness of alternative implementation strategies and policies for health and wellness programs.
#46	Develop a physical fitness risk assessment tool for wildland firefighters.
#47	Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks.
#48	Research the development of technology, tactics and response standards in the wildland-urban interface. Include PPE requirements for all responders.
#49	Align research projects with strategies to enhance the benefits of the research. Identify data and technology formats that are most beneficial to the fire service.
#50	Conduct research to make improvements in the survivability of fire apparatus crashes. Conduct research related to anthropometric and ergonomic challenges in fire apparatus construction and arrangements that lead to frequent head and musculoskeletal injuries.
#51	Develop a user-friendly technological accountability system for use on the fireground.
#52	Evaluate existing ballistic protection options (including helmets) for firefighters and EMS responders. As indicated by findings, develop new options.
#53	Determine the necessary components to be included in the educational process for incident commanders, taking into account risk management, tactics, operational concerns and an acceptable knowledge base.
#54	Research the application of unmanned aerial vehicles for the fire service.

Appendix C: Participants and their Organizations

Name	Organization
Robert Athanas	NFPA Technical Committee on Electronic Safety Equipment
Roger Barker	North Carolina State University
Sharon Baroncelli	National Fallen Firefighters Foundation
Nick Baskerville	International Association of Black Professional Fire Fighters
Richard Best	National Fallen Firefighters Everyone Goes Home® Program
Matthew Biffen	National Fallen Firefighters Everyone Goes Home® Program
Marion Blackwell	Spartanburg (SC) Fire Department
Paul Bourgeois	Superstition (AZ) Fire & Medical District
Richard Bowers	Fairfax County (VA) Fire and Rescue Department
Curtis Brown*	CAL FIRE Local 2881
George Broyles	U.S. Forest Service
Nelson Bryner*	National Institute of Standards & Technology
Rachel Buczynski	National Volunteer Fire Council
Jeff Burgess, M.D.	University of Arizona
Paul Cerda	National Park Service Wildland Fire Management
John Ceriello	FDNY
Tony Coleman	Montgomery County (MD) Fire and Rescue Service
Dennis Compton	National Fallen Firefighters Foundation
Henry Costo	LION/Costo Fire Consulting, LLC
Mark Davis	Charleston (SC) Fire Department
Sean DeCrane	International Association of Fire Fighters
Charlie Dickinson	U.S. Fire Administration (retired) Pittsburgh (PA) Bureau of Fire (retired)
John Dixon	National Fallen Firefighters Everyone Goes Home® Program
Joe Domitrovich, Ph.D.	U.S. Forest Service
Cindy Ell	International Firefighter Cancer Foundation
David Evans	FEMA/DHS
Rita Fahy, Ph.D.	NFPA
Kenneth Fent, Ph.D.	CDC/NIOSH
John Gallo	Montgomery County (MD) Fire and Rescue Service
John Granito, Ph.D.*	SUNY Binghamton (retired)
Daniel Gray	Fairfax County (VA) Fire and Rescue Department
Robert Halton	Pennwell Fire Group
Todd Harms	Phoenix (AZ) Fire Department
J. Jafari Harris	San Diego (CA) Fire-Rescue Department
Julie Hartell, Ph.D.	Oklahoma State University
Brad Harvey	Scott Safety
William Haskell	NIOSH-NPPTL
Tim Hill	United Phoenix Fire Fighters Association
Christina Holcroft	NFPA

Gavin Horn, Ph.D.	Illinois Fire Service Institute
Angela Hughes	International Association of Women in Fire & Emergency Services
Sarah Jahnke, Ph.D.	Center for Fire Rescue & EMS Health Research
Charles Jennings, Ph.D.	Christian Regenhard Center for Emergency Response Studies
Deborah Keeler	International Association of Arson Investigators
JoEllen Kelly, Ph.D.	National Fallen Firefighters Foundation
Steve Kerber*	UL Firefighter Safety Research Institute
Dan Kerrigan	International Association of Fire Chiefs- Volunteer and Combination Officers Section
Richard Kesler	Illinois Fire Service Institute
Bob Keys	FDNY Consulting LLC
Melissa Knight	International Association of Fire Chiefs-FSTAR
Murrey Loflin	NIOSH Fire Fighter Fatality Investigation and Prevention Program
Jo-Ann Lorber*	International Association of Fire Chiefs
Scott Low	National Fallen Firefighters Everyone Goes Home® Program
Daniel Madrzykowski	National Institute of Standards & Technology
Robert Manwaring	USDA Forest Service
Alexander Maranghides	National Institute of Standards & Technology
James Masiello	Fairfax County (VA) Fire and Rescue Department
Greg Mears, M.D.	National Fire Operations Reporting System (N-FORS)
Brian Meacham, Ph.D.	Worcester Polytechnic Institute
Tim Merinar	NIOSH Fire Fighter Fatality Investigation and Prevention Program
Jeffrey Merryman*	Fire Department Safety Officers Association
Richard Miller	International Association of Fire Chiefs-FSTAR
Lori Moore-Merrell, DrPH*	International Association of Fire Fighters
Patrick Morrison	International Association of Fire Fighters
Joseph Namm	Motorola Solutions
Mike Novak	National Fallen Firefighters Everyone Goes Home® Program
John Oates	East Hartford (CT) Fire Department
Brenden Orth	National Fallen Firefighters Everyone Goes Home® Program
Cathie Patterson	FEMA/DHS
Stephen Pegram	International Society of Fire Safety Instructors
Nicholas Perkins	National Fallen Firefighters Everyone Goes Home® Program
Lawrence Petrick	International Association of Fire Fighters
Edward Plaugher	Arlington County (VA) Fire Department (retired)
Brett Pollock	National Fallen Firefighters Everyone Goes Home® Program
Vickie Pritchett	National Fire Sprinkler Association
Tim Radtke	U.S. Department of the Interior
Shane Ray	National Fire Sprinkler Association
Jim Reidy	San Antonio (TX) Fire Department
Russell Renck	Colorado Springs (CO) Fire Department
Lillian Ricardo	FEMA/DHS
Allan Rice*	North American Fire Training Directors
Kevin Roche	National Fallen Firefighters Foundation

J. Gordon Routley	National Fallen Firefighters Foundation
Jay Ruoff	National Fallen Firefighters Everyone Goes Home® Program
Tricia Sanborn	National Fallen Firefighters Foundation
Ronald Siarnicki	National Fallen Firefighters Foundation
Denise Smith, Ph.D.	Skidmore College
Joe Sol	USDA Forest Service
Victor Stagnaro	National Fallen Firefighters Foundation
Richard Swan	International Association of Fire Fighters
Jennifer Taylor, Ph.D.	Drexel University School of Public Health
Tracy Thomas	IAFC-Safety Health and Survival Section
Amy Tippett	National Fallen Firefighters Foundation
John Tippett*	Charleston (SC) Fire Department
Matthew Tobia	IAFC-Safety Health and Survival Section
Nathan Trauernicht	International Association of Fire Chiefs
Nancy Trench	IFSTA/OSU Fire Protection Publications
Bill Troup	U.S. Fire Administration
Robert Tutterow*	F.I.E.R.O. (Fire Industry Education Resource Organization)
Keith Tyson	Firefighter Cancer Support Network
Joey Underwood	Safety Components
Bruce Varner	Institute of Fire Engineers
Jason Virtue	U.S. Forest Service
Michael Wieder*	IFSTA/OSU Fire Protection Publications
Maggie Wilson	FEMA/DHS
Derek Wheeler	Colorado Springs (CO) Fire Department
Dennis Wood	Prince George's County (MD) Fire/EMS Department
Robin Zevotek	UL Firefighter Safety Research Institute

*Indicates Jury Panel Member

Appendix D: 2015 Recommendations – Apparatus

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Conduct research into establishing safe and reliable aircraft operations in the wildland-urban interface. (#41)	Medium
Conduct research to make improvements in the survivability of fire apparatus crashes. Conduct research related to anthropometric and ergonomic challenges in fire apparatus construction and arrangements that lead to frequent head and musculoskeletal injuries. (#50)	Medium
Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway). (#39)	Medium

Appendix E: 2015 Recommendations – Community Risk Reduction

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Assess the effectiveness of risk reduction messages in successfully changing targeted behaviors. (#13)	High
Assess the effectiveness of the adoption of codes and standards in reducing the incidence and impact of fires by comparing results in locales that adopted codes and those that did not. (#29)	Medium
Assess the impact of current fire dynamics research on the health of fire investigators. (#30)	Medium
Assess the impact/influence of the adoption/enforcement of codes on the economic impact of wildland-urban interface fires. Consider the impact on both wildland to urban and urban to wildland fire transitions. Examine the impact on fire ignitions and loss. (#31)	Medium
Assess the overall effectiveness of fire and injury reduction programs on the accomplishment of targeted reductions in fatalities, injuries and property loss. (#32)	Medium
Assess the reliability and performance characteristics of alternative smoke alarm technologies. (#14)	High
Create a searchable database of community risk reduction programs that have been identified as best practices in communities and/or states. (#12)	Low
Develop methods to evaluate and quantify the direct and indirect economic impacts of fire service response and operations on property, people and the environment. (#37)	Medium
Identify and make use of traditional and non-traditional data to supplement, update and enhance fire service programs, including fire suppression and emergency operations, public education, fire prevention and community risk reduction efforts. (#7)	High
Measure the fire growth rate in new homes which are built to modern energy codes and specifications and furnished with contemporary fire loads. Simulate and evaluate escape times based on the realistic capabilities of individuals. (#44)	Low

Appendix F: 2015 Recommendations – Data

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Assess the effectiveness of risk reduction messages in successfully changing targeted behaviors. (#13)	High
Assess the effectiveness of the adoption of codes and standards in reducing the incidence and impact of fires by comparing results in locales that adopted codes and those that did not. (#29)	Medium
Assess the impact of current fire dynamics research on the health of fire investigators. (#30)	Medium
Assess the impact/influence of the adoption/enforcement of codes on the economic impact of wildland-urban interface fires. Consider the impact on both wildland to urban and urban to wildland fire transitions. Examine the impact on fire ignitions and loss. (#31)	Medium
Assess the overall effectiveness of fire and injury reduction programs on the accomplishment of targeted reductions in fatalities, injuries and property loss. (#32)	Medium
Conduct a cost/benefit analysis of investing in fire department occupational health and safety programs, including identification of best practices and methods to institute such programs. (#15)	High
Conduct a study of the life span of PPE. (#16)	High
Conduct research based on fire dynamics to identify best practices at the strategic, tactical and task levels for firefighting operations in new and existing commercial and residential structures. The research should include the creation of on-scene risk assessment tools based on specific fire factors to assist company officers and incident commanders. (#17)	High
Conduct research directed toward identifying and overcoming barriers to the implementation of tobacco cessation programs and the elimination of all forms of tobacco and nicotine use (e.g. cigarettes, smokeless tobacco, e-cigarettes, other vape products). Conduct studies related to alcohol abuse, misuse and abuse of prescription drugs and illicit drugs. (#18)	High
Conduct research directed toward identifying those individuals within the fire service who are at a higher risk for specific occupational injury/illness/disease. (#1)	High
Conduct research into establishing safe and reliable aircraft operations in the wildland-urban interface. (#41)	Medium

Conduct research based on fire dynamics to identify best practices at the strategic, tactical and task levels for firefighting operations in new and existing commercial and residential structures. The research should include the creation of on-scene risk assessment tools based on specific fire factors to assist company officers and incident commanders. (#17)	High
Conduct research on how science can improve wildland firefighting training, tactics and response to reduce fatalities, injuries and unintended outcomes. (#20)	High
Conduct research on the effectiveness of alternative implementation strategies and policies for health and wellness programs. (#45)	Low
Conduct research on the risks and/or benefits of supplements (e.g. nutritional supplements, sports energy drinks, creatine and testesterone). (#42)	Medium
Conduct research to make improvements in the survivability of fire apparatus crashes. Conduct research related to anthropometric and ergonomic challenges in fire apparatus construction and arrangements that lead to frequent head and musculoskeletal injuries. (#50)	Medium
Continue progress toward the development and refinement of enhanced data systems (such as N-FORS) across all fire service domains. (#2)	High
Continue research into operational practices directed toward more effective tactics, improvements in firefighter safety and victim survivability and reductions in property losses. These studies should specifically address staffing and deployment, fire dynamics research and victim survivability. The focus should include high-rise residential and commercial buildings, private dwellings, multiple unit residential occupancies, strip malls, taxpayer buildings and warehouses. (#21)	High
Continue research on firefighter health, injury and diseases related to chronic and repeated exposures to the risks of emergency incidents and the fire service work environment. The research should include all disciplines including wildland and wildland-urban interface. (#22)	High
Continue research on firefighter health, injury and diseases related to the risks of acute exposures that may result from emergency incidents. (#23)	High
Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks. (#47)	High
Create a searchable database of community risk reduction programs that have been identified as best practices in communities and/or states. (#12)	Low
Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds. (#35)	Medium

Determine the efficacy/effectiveness of interventions/programs/systems designed to decrease disease/exposure/injury/death and increase medical evaluations, occupational health and surveillance. The research should include under-researched populations within the fire service and include a focus on reproductive, maternal and child health issues, cardiovascular risk factors, injuries and cancer. (#24)	High
Determine the incidence and frequency of occupational diseases/illness/injury/conditions in underrepresented groups and those with unique exposures.(#9)	Medium
Determine the necessary components to be included in the educational process for incident commanders, taking into account risk management, tactics, operational concerns and an acceptable knowledge base. (#53)	Low
Develop a centralized data warehouse and common data elements to facilitate research related to wildland firefighting. (#3)	High
Develop a unified national database with common definitions on fire service fatalities, injuries and occupational illnesses. (#4)	High
Develop methods to evaluate and quantify the direct and indirect economic impacts of fire service response and operations on property, people and the environment. (#37)	Medium
Establish a center for best practices for data collection and analysis. Identify and catalog data sources and technology formats that are relevant and beneficial for the fire service. (#10)	Medium
Evaluate behavior modification strategies that will lead to lasting cultural changes resulting in improvements in data collection and use. (#5)	High
Evaluate the impact of modern and evolving building technology (i.e. green buildings, solar and battery storage systems) on fire service operations. Create a knowledge base for incident commanders, company officers and firefighters to support operational safely and proficiently. (#38)	Medium
Identify and develop methods to capture operational data on fireground performance, mental resiliency, effective communications and operational benchmarks. (#6)	High
Identify and make use of traditional and non-traditional data to supplement, update and enhance fire service programs, including fire suppression and emergency operations, public education, fire prevention and community risk reduction efforts. (#7)	High
Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway). (#39)	Medium
Identify respiratory contaminants and determine the potential adverse health outcomes associated with wildland and wildland-urban interface fire operations. Also, determine the adequate respiratory protection for wildland firefighters. (#25)	High
Improve local data collection in order to positively impact efficient service delivery, professional development and organizational health. (#8)	High

Measure the fire growth rate in new homes which are built to modern energy codes and specifications and furnished with contemporary fire loads. Simulate and evaluate escape times based on the realistic capabilities of individuals. (#44)	Low
Research the impact of communication failures with portable radio systems and devices as a contributing factor in firefighter injuries and fatalities. Address alternative radio system configurations to ensure reliable in-building radio communications. Also, examine potential improvements in radio construction, ergonomics and the ability to interface portable radios with other technologies to track firefighters in the fire environment. (#27)	High
Research total worker health of the wildland firefighter population to improve health and wellness.(#11)	Medium

Appendix G: 2015 Recommendations – Economic Impact

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Align research projects with strategies to enhance the benefits of the research. Identify data and technology formats that are most beneficial to the fire service. (#49)	Medium
Assess the effectiveness of the adoption of codes and standards in reducing the incidence and impact of fires by comparing results in locales that adopted codes and those that did not. (#29)	Medium
Assess the impact/influence of the adoption/enforcement of codes on the economic impact of wildland-urban interface fires. Consider the impact on both wildland to urban and urban to wildland fire transitions. Examine the impact on fire ignitions and loss. (#31)	Medium
Assess the overall effectiveness of fire and injury reduction programs on the accomplishment of targeted reductions in fatalities, injuries and property loss. (37)	Medium
Assess the reliability and performance characteristics of alternative smoke alarm technologies. (#14)	High
Conduct a cost/benefit analysis of investing in fire department occupational health and safety programs, including identification of best practices and methods to institute such programs. (#15)	High
Conduct a study of the life span of PPE. (#16)	High
Conduct research on the translation, dissemination and messaging of current knowledge and best practices related to health and wellness programs, including physical fitness, health maintenance, nutrition and annual medical evaluations. (#34)	Medium
Conduct research to make improvements in the survivability of fire apparatus crashes. Conduct research related to anthropometric and ergonomic challenges in fire apparatus construction and arrangements that lead to frequent head and musculoskeletal injuries. (#50)	Medium
Continue progress toward the development and refinement of enhanced data systems (such as N-FORS) across all fire service domains. (#2)	High
Develop a user-friendly technological accountability system for use on the fireground. (#51)	Medium
Develop methods to evaluate and quantify the direct and indirect economic impacts of fire service response and operations on property, people and the environment. (#37)	Medium

Identify and make use of traditional and non-traditional data to supplement, update and enhance fire service programs, including fire suppression and emergency operations, public education, fire prevention and community risk reduction efforts. (#7)	High

Appendix H: 2015 Recommendations – Effectiveness/Impact

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Align research projects with strategies to enhance the benefits of the research. Identify data and technology formats that are most beneficial to the fire service. (#49)	Medium
Assess substance misuse and abuse in the fire service (including, but not limited to alcohol, prescription drugs and illicit drugs). Focus research on the identification of effective prevention efforts, interventions and rehabilitation strategies. (#28)	Medium
Assess the effectiveness of risk reduction messages in successfully changing targeted behaviors. (#13)	High
Assess the effectiveness of the adoption of codes and standards in reducing the incidence and impact of fires by comparing results in locales that adopted codes and those that did not. (#29)	Medium
Assess the overall effectiveness of fire and injury reduction programs on the accomplishment of targeted reductions in fatalities, injuries and property loss. (#32)	Medium
Assess the reliability and performance characteristics of alternative smoke alarm technologies. (#14)	High
Conduct a cost/benefit analysis of investing in fire department occupational health and safety programs, including identification of best practices and methods to institute such programs. (#15)	High
Conduct research based on fire dynamics to identify best practices at the strategic, tactical and task levels for firefighting operations in new and existing commercial and residential structures. The research should include the creation of on-scene risk assessment tools based on specific fire factors to assist company officers and incident commanders. (#17)	High
Conduct research directed toward identifying and overcoming barriers to the implementation of tobacco cessation programs and the elimination of all forms of tobacco and nicotine use (e.g. cigarettes, smokeless tobacco, e-cigarettes, other vape products). Conduct studies related to alcohol abuse, misuse and abuse of prescription drugs and illicit drugs. (#18)	High
Conduct research on cleaning methods for firefighter protective clothing, including potential impacts on the protective properties and useful life of the clothing, and determining effectiveness of removal of suspected carcinogens and other contaminants. (#33)	Medium

Conduct research on enhanced dermal protection provided by firefighter structural protective clothing, particularly as it relates to reducing exposures to known and suspected carcinogens. (#19)	High
Conduct research on the efficacy and effectiveness of health and wellness programs for individuals and organizations. Focus on programs directed toward preventive behavioral change. The research areas should include fitness, nutrition, hydration, sleep and hygiene. (#43)	Low
Conduct research on the translation, dissemination and messaging of current knowledge and best practices related to health and wellness programs, including physical fitness, health maintenance, nutrition and annual medical evaluations. (#34)	Medium
Conduct research to make improvements in the survivability of fire apparatus crashes. Conduct research related to anthropometric and ergonomic challenges in fire apparatus construction and arrangements that lead to frequent head and musculoskeletal injuries. (#50)	Medium
Continue progress toward the development and refinement of enhanced data systems (such as N-FORS) across all fire service domains. (#2)	High
Continue research into operational practices directed toward more effective tactics, improvements in firefighter safety and victim survivability and reductions in property losses. These studies should specifically address staffing and deployment, fire dynamics research and victim survivability. The focus should include high-rise residential and commercial buildings, private dwellings, multiple unit residential occupancies, strip malls, taxpayer buildings and warehouses. (#21)	High
Continue research on firefighter health, injury and diseases related to chronic and repeated exposures to the risks of emergency incidents and the fire service work environment. The research should encompass all disciplines including wildland and wildland-urban interface. (#22)	High
Continue research on firefighter health, injury and diseases related to the risks of acute exposures that may result from emergency incidents. (#23)	High
Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks. (#47)	High
Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds. (#35)	Medium
Determine the efficacy/effectiveness of interventions/programs/systems designed to decrease disease/exposure/injury/death and increase medical evaluations, occupational health and surveillance. The research should include under-researched populations within the fire service and include a focus on reproductive, maternal and child health issues, cardiovascular risk factors, injuries and cancer. (#24)	High
Determine the most effective implementation methods to institute occupational health programs. (#36)	Medium

Develop a user-friendly technological accountability system for use on the fireground. (#51)	Medium
Evaluate behavior modification strategies that will lead to lasting cultural changes resulting in improvements in data collection and use. (#5)	High
Evaluate existing ballistic protection options (including helmets) for firefighters and EMS responders. As indicated by findings, develop new options. (#52)	Medium
Evaluate the impact of modern and evolving building technology (i.e. green buildings, solar and battery storage systems) on fire service operations. Create a knowledge base for incident commanders, company officers and firefighters to support operational safely and proficiently. (#38)	Medium
Identify and make use of traditional and non-traditional data to supplement, update and enhance fire service programs, including fire suppression and emergency operations, public education, fire prevention and community risk reduction efforts. (#7)	High
Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway). (#39)	Medium
Identify, develop and refine evidence-based tools and approaches for behavioral health screening, assessment and intervention. (#26)	High
Improve local data collection in order to positively impact efficient service delivery, professional development and organizational health. (#8)	High
Research the effectiveness of alternative learning mechanisms in order to identify and develop the best firefighter training delivery system(s) for strategic, tactical and task level operations. (#40)	Medium
Research the impact of communication failures with portable radio systems and devices as a contributing factor in firefighter injuries and fatalities. Address alternative radio system configurations to ensure reliable in-building radio communications. Also, examine potential improvements in radio construction, ergonomics and the ability to interface portable radios with other technologies to track firefighters in the fire environment. (#27)	High

Appendix I: 2015 Recommendations – Emergency Operations

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Conduct research based on fire dynamics to identify best practices at the strategic, tactical and task levels for firefighting operations in new and existing commercial and residential structures. The research should include the creation of on-scene risk assessment tools based on specific fire factors to assist company officers and incident commanders. (#17)	High
Conduct research into establishing safe and reliable aircraft operations in the wildland-urban interface. (#41)	Medium
Conduct research on how science can improve wildland firefighting training, tactics and response to reduce fatalities, injuries and unintended outcomes. (#20)	High
Continue progress toward the development and refinement of enhanced data systems (such as N-FORS) across all fire service domains. (#2)	High
Continue research into operational practices directed toward more effective tactics, improvements in firefighter safety and victim survivability and reductions in property losses. These studies should specifically address staffing and deployment, fire dynamics research and victim survivability. The focus should include high-rise residential and commercial buildings, private dwellings, multiple unit residential occupancies, strip malls, taxpayer buildings and warehouses. (#21)	High
Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks. (#47)	High
Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds. (#35)	Medium
Determine the necessary components to be included in the educational process for incident commanders, taking into account risk management, tactics, operational concerns and an acceptable knowledge base. (#53)	Low
Develop a user-friendly technological accountability system for use on the fireground. (#51)	Medium
Evaluate existing ballistic protection options (including helmets) for firefighters and EMS responders. As indicated by findings, develop new options. (#52)	Medium

Evaluate the impact of modern and evolving building technology (i.e. green buildings, solar and battery storage systems) on fire service operations. Create a knowledge base for incident commanders, company officers and firefighters to support operational safely and proficiently. (#38)	Medium
Identify and develop methods to capture operational data on fireground performance, mental resiliency, effective communications and operational benchmarks. (#6)	High
Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway). (#39)	Medium
Identify respiratory contaminants and determine the potential adverse health outcomes associated with wildland and wildland-urban interface fire operations. Also, determine the adequate respiratory protection for wildland firefighters. (#25)	High
Research the application of unmanned aerial vehicles for the fire service. (#54)	Low
Research the development of technology, tactics and response standards in the wildland-urban interface. Include PPE requirements for all responders. (#48)	High
Research the effectiveness of alternative learning mechanisms in order to identify and develop the best firefighter training delivery system(s) for strategic, tactical and task level operations. (#40)	Medium
Research the impact of communication failures with portable radio systems and devices as a contributing factor in firefighter injuries and fatalities. Address alternative radio system configurations to ensure reliable in-building radio communications. Also, examine potential improvements in radio construction, ergonomics and the ability to interface portable radios with other technologies to track firefighters in the fire environment. (#27)	High

Appendix J: 2015 Recommendations – Greater Good

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Assess substance misuse and abuse in the fire service (including, but not limited to alcohol, prescription drugs and illicit drugs). Focus research on the identification of effective prevention efforts, interventions and rehabilitation strategies. (#28)	Medium
Assess the impact of current fire dynamics research on the health of fire investigators. (#30)	Medium
Assess the overall effectiveness of fire and injury reduction programs on the accomplishment of targeted reductions in fatalities, injuries and property loss. (#32)	Medium
Conduct a cost/benefit analysis of investing in fire department occupational health and safety programs, including identification of best practices and methods to institute such programs. (#15)	High
Conduct research directed toward identifying and overcoming barriers to the implementation of tobacco cessation programs and the elimination of all forms of tobacco and nicotine use (e.g. cigarettes, smokeless tobacco, e-cigarettes, other vape products). Conduct studies related to alcohol abuse, misuse and abuse of prescription drugs and illicit drugs. (#18)	High
Conduct research directed toward identifying those individuals within the fire service who are at a higher risk for specific occupational injury/illness/disease. (#1)	High
Conduct research on cleaning methods for firefighter protective clothing, including potential impacts on the protective properties and useful life of the clothing, and determining effectiveness of removal of suspected carcinogens and other contaminants. (#33)	Medium
Conduct research on enhanced dermal protection provided by firefighter structural protective clothing, particularly as it relates to reducing exposures to known and suspected carcinogens. (#19)	High
Conduct research on the risks and/or benefits of supplements (e.g. nutritional supplements, sports energy drinks, creatine and testesterone). (#42)	Medium
Conduct research to make improvements in the survivability of fire apparatus crashes. Conduct research related to anthropometric and ergonomic challenges in fire apparatus construction and arrangements that lead to frequent head and musculoskeletal injuries. (#50)	Medium
Continue progress toward the development and refinement of enhanced data systems (such as N-FORS) across all fire service domains. (#2)	High

Continue research on firefighter health, injury and diseases related to chronic and repeated exposures to the risks of emergency incidents and the fire service work environment. The research should encompass all disciplines including wildland and wildland-urban interface. (#22)	High
Continue research on firefighter health, injury and diseases related to the risks of acute exposures that may result from emergency incidents. (#23)	High
Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks. (#47)	High
Create a searchable database of community risk reduction programs that have been identified as best practices in communities and/or states. (#12)	Low
Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds. (#35)	Medium
Determine the efficacy/effectiveness of interventions/programs/systems designed to decrease disease/exposure/injury/death and increase medical evaluations, occupational health and surveillance. The research should include under-researched populations within the fire service and include a focus on reproductive, maternal and child health issues, cardiovascular risk factors, injuries and cancer. (#24)	High
Determine the incidence and frequency of occupational diseases/illness/injury/conditions in underrepresented groups and those with unique exposures. (#9)	Medium
Determine the most effective implementation methods to institute occupational health programs. (#36)	Medium
Determine the necessary components to be included in the educational process for incident commanders, taking into account risk management, tactics, operational concerns and an acceptable knowledge base. (#53)	Low
Develop a unified national database with common definitions on fire service fatalities, injuries and occupational illnesses. (#4)	High
Develop methods to evaluate and quantify the direct and indirect economic impacts of fire service response and operations on property, people and the environment. (#37)	Medium
Establish a center for best practices for data collection and analysis. Identify and catalog data sources and technology formats that are relevant and beneficial for the fire service. (#10)	Medium
Evaluate behavior modification strategies that will lead to lasting cultural changes resulting in improvements in data collection and use. (#5)	High
Evaluate existing ballistic protection options (including helmets) for firefighters and EMS responders. As indicated by findings, develop new options. (#52)	Medium

Evaluate the impact of modern and evolving building technology (i.e. green buildings, solar and battery storage systems) on fire service operations. Create a knowledge base for incident commanders, company officers and firefighters to support operational safely and proficiently. (#38)	Medium
Identify and develop methods to capture operational data on fireground performance, mental resiliency, effective communications and operational benchmarks. (#6)	High
Identify and make use of traditional and non-traditional data to supplement, update and enhance fire service programs, including fire suppression and emergency operations, public education, fire prevention and community risk reduction efforts. (#7)	High
Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway). (#39)	Medium
Identify respiratory contaminants and determine the potential adverse health outcomes associated with wildland and wildland-urban interface fire operations. Also, determine the adequate respiratory protection for wildland firefighters. (#25)	High
Identify, develop and refine evidence-based tools and approaches for behavioral health screening, assessment and intervention. (#26)	High
Improve local data collection in order to positively impact efficient service delivery, professional development and organizational health. (#8)	High
Measure the fire growth rate in new homes which are built to modern energy codes and specifications and furnished with contemporary fire loads. Simulate and evaluate escape times based on the realistic capabilities of individuals. (#44)	Low
Research the development of technology, tactics and response standards in the wildland-urban interface. Include PPE requirements for all responders. (#48)	High
Research the effectiveness of alternative learning mechanisms in order to identify and develop the best firefighter training delivery system(s) for strategic, tactical and task level operations. (#40)	Medium
Research the impact of communication failures with portable radio systems and devices as a contributing factor in firefighter injuries and fatalities. Address alternative radio system configurations to ensure reliable in-building radio communications. Also, examine potential improvements in radio construction, ergonomics and the ability to interface portable radios with other technologies to track firefighters in the fire environment. (#27)	High

Appendix K: 2015 Recommendations – Health and Wellness

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Assess substance misuse and abuse in the fire service (including, but not limited to alcohol, prescription drugs and illicit drugs). Focus research on the identification of effective prevention efforts, interventions and rehabilitation strategies. (#28)	Medium
Assess the impact of current fire dynamics research on the health of fire investigators. (#30)	Medium
Conduct a cost/benefit analysis of investing in fire department occupational health and safety programs, including identification of best practices and methods to institute such programs. (#15)	High
Conduct research directed toward identifying and overcoming barriers to the implementation of tobacco cessation programs and the elimination of all forms of tobacco and nicotine use (e.g. cigarettes, smokeless tobacco, e-cigarettes, other vape products). Conduct studies related to alcohol abuse, misuse and abuse of prescription drugs and illicit drugs. (#18)	High
Conduct research directed toward identifying those individuals within the fire service who are at a higher risk for specific occupational injury/illness/disease. (#1)	High
Conduct research on cleaning methods for firefighter protective clothing, including potential impacts on the protective properties and useful life of the clothing, and determining effectiveness of removal of suspected carcinogens and other contaminants. (#33)	Medium
Conduct research on enhanced dermal protection provided by firefighter structural protective clothing, particularly as it relates to reducing exposures to known and suspected carcinogens. (#19)	High
Conduct research on the effectiveness of alternative implementation strategies and policies for health and wellness programs. (#45)	Low
Conduct research on the efficacy and effectiveness of health and wellness programs for individuals and organizations. Focus on programs directed toward preventive behavioral change. The research areas should include fitness, nutrition, hydration, sleep and hygiene. (#43)	Low
Conduct research on the risks and/or benefits of supplements (e.g. nutritional supplements, sports energy drinks, creatine and testesterone). (#42)	Medium

Conduct research on the translation, dissemination and messaging of current knowledge and best practices related to health and wellness programs, including physical fitness, health maintenance, nutrition and annual medical evaluations. (#34)	Medium
Continue research on firefighter health, injury and diseases related to chronic and repeated exposures to the risks of emergency incidents and the fire service work environment. The research should include encompass all disciplines including wildland and wildland-urban interface. (#22)	High
Continue research on firefighter health, injury and diseases related to the risks of acute exposures that may result from emergency incidents. (#23)	High
Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds. (#35)	Medium
Determine the efficacy/effectiveness of interventions/programs/systems designed to decrease disease/exposure/injury/death and increase medical evaluations, occupational health and surveillance. The research should include under-researched populations within the fire service and include a focus on reproductive, maternal and child health issues, cardiovascular risk factors, injuries and cancer. (#24)	High
Determine the incidence and frequency of occupational diseases/illness/injury/conditions in underrepresented groups and those with unique exposures. (#9)	Medium
Determine the most effective implementation methods to institute occupational health programs. (#36)	Medium
Develop a physical fitness risk assessment tool for wildland firefighters. (#46)	Low
Develop a unified national database with common definitions on fire service fatalities, injuries and occupational illnesses. (#4)	High
Identify and develop methods to capture operational data on fireground performance, mental resiliency, effective communications and operational benchmarks. (#6)	High
Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway). (#39)	Medium
Identify respiratory contaminants and determine the potential adverse health outcomes associated with wildland and wildland-urban interface fire operations. Also, determine the adequate respiratory protection for wildland firefighters. (#25)	High
Identify, develop and refine evidence-based tools and approaches for behavioral health screening, assessment and intervention. (#26)	High
Improve local data collection in order to positively impact efficient service delivery, professional development and organizational health. (#8)	High
Research total worker health of the wildland firefighter population to improve health and wellness. (#11)	Medium

Appendix L: 2015 Recommendations – Messaging

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Align research projects with strategies to enhance the benefits of the research. Identify data and technology formats that are most beneficial to the fire service. (#49)	Medium
Assess the effectiveness of risk reduction messages in successfully changing targeted behaviors. (#13)	High
Assess the effectiveness of the adoption of codes and standards in reducing the incidence and impact of fires by comparing results in locales that adopted codes and those that did not. (#29)	Medium
Conduct research directed toward identifying and overcoming barriers to the implementation of tobacco cessation programs and the elimination of all forms of tobacco and nicotine use (e.g. cigarettes, smokeless tobacco, e-cigarettes, other vape products). Conduct studies related to alcohol abuse, misuse and abuse of prescription drugs and illicit drugs. (#18)	High
Conduct research on the risks and/or benefits of supplements (e.g. nutritional supplements, sports energy drinks, creatine and testesterone). (#42)	Medium
Conduct research on the translation, dissemination and messaging of current knowledge and best practices related to health and wellness programs, including physical fitness, health maintenance, nutrition and annual medical evaluations. (#34)	Medium
Continue progress toward the development and refinement of enhanced data systems (such as N-FORS) across all fire service domains. (#2)	High
Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks. (#47)	High
Create a searchable database of community risk reduction programs that have been identified as best practices in communities and/or states. (#12)	Low
Determine the most effective implementation methods to institute occupational health programs. (#36)	Medium
Determine the necessary components to be included in the educational process for incident commanders, taking into account risk management, tactics, operational concerns and an acceptable knowledge base. (#53)	Low
Evaluate behavior modification strategies that will lead to lasting cultural changes resulting in improvements in data collection and use. (#5)	High

Identify and develop methods to capture operational data on fireground performance, mental resiliency, effective communications and operational benchmarks. (#6)	High
Identify and make use of traditional and non-traditional data to supplement, update and enhance fire service programs, including fire suppression and emergency operations, public education, fire prevention and community risk reduction efforts. (#7)	High

Appendix M: 2015 Recommendations – Occupational Diseases

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Assess the impact of current fire dynamics research on the health of fire investigators. (#30)	Medium
Conduct a cost/benefit analysis of investing in fire department occupational health and safety programs, including identification of best practices and methods to institute such programs. (#15)	High
Conduct research directed toward identifying those individuals within the fire service who are at a higher risk for specific occupational injury/illness/disease. (#1)	High
Conduct research on cleaning methods for firefighter protective clothing, including potential impacts on the protective properties and useful life of the clothing, and determining effectiveness of removal of suspected carcinogens and other contaminants. (#33)	Medium
Conduct research on enhanced dermal protection provided by firefighter structural protective clothing, particularly as it relates to reducing exposures to known and suspected carcinogens. (#19)	High
Conduct research on the translation, dissemination and messaging of current knowledge and best practices related to health and wellness programs, including physical fitness, health maintenance, nutrition and annual medical evaluations. (#34)	Medium
Continue research on firefighter health, injury and diseases related to chronic and repeated exposures to the risks of emergency incidents and the fire service work environment. The research should encompass all disciplines including wildland and wildland-urban interface. (#22)	High
Continue research on firefighter health, injury and diseases related to the risks of acute exposures that may result from emergency incidents. (#23)	High
Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds. (#35)	Medium
Determine the efficacy/effectiveness of interventions/programs/systems designed to decrease disease/exposure/injury/death and increase medical evaluations, occupational health and surveillance. The research should include under-researched populations within the fire service and include a focus on reproductive, maternal and child health issues, cardiovascular risk factors, injuries and cancer. (#24)	High

Determine the incidence and frequency of occupational diseases/illness/injury/conditions in underrepresented groups and those with unique exposures. (#9)	Medium
Determine the most effective implementation methods to institute occupational health programs. (#36)	Medium
Develop a unified national database with common definitions on fire service fatalities, injuries and occupational illnesses. (#4)	High
Identify respiratory contaminants and determine the potential adverse health outcomes associated with wildland and wildland-urban interface fire operations. Also, determine the adequate respiratory protection for wildland firefighters. (#25)	High
Improve local data collection in order to positively impact efficient service delivery, professional development and organizational health. (#8)	High
Research total worker health of the wildland firefighter population to improve health and wellness. (#11)	Medium

Appendix N: 2015 Recommendations – Personal Protective Equipment

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Conduct a study of the life span of PPE. (#16)	High
Conduct research on cleaning methods for firefighter protective clothing, including potential impacts on the protective properties and useful life of the clothing, and determining effectiveness of removal of suspected carcinogens and other contaminants. (#33)	Medium
Conduct research on enhanced dermal protection provided by firefighter structural protective clothing, particularly as it relates to reducing exposures to known and suspected carcinogens. (#19)	High
Continue research into operational practices directed toward more effective tactics, improvements in firefighter safety and victim survivability and reductions in property losses. These studies should specifically address staffing and deployment, fire dynamics research and victim survivability. The focus should include high-rise residential and commercial buildings, private dwellings, multiple unit residential occupancies, strip malls, taxpayer buildings and warehouses. (#21)	High
Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks. (#47)	High
Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds. (#35)	Medium
Evaluate existing ballistic protection options (including helmets) for firefighters and EMS responders. As indicated by findings, develop new options. (#52)	Medium
Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway). (#39)	Medium
Identify respiratory contaminants and determine the potential adverse health outcomes associated with wildland and wildland-urban interface fire operations. Also, determine the adequate respiratory protection for wildland firefighters. (#25)	High
Research the development of technology, tactics and response standards in the wildland-urban interface. Include PPE requirements for all responders. (#48)	High

Appendix O: 2015 Recommendations – Technology

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Assess the impact/influence of the adoption/enforcement of codes on the economic impact of wildland-urban interface fires. Consider the impact on both wildland to urban and urban to wildland fire transitions. Examine the impact on fire ignitions and loss. (#31)	Medium
Assess the reliability and performance characteristics of alternative smoke alarm technologies. (#14)	High
Conduct a study of the life span of PPE. (#16)	High
Conduct research based on fire dynamics to identify best practices at the strategic, tactical and task levels for firefighting operations in new and existing commercial and residential structures. The research should include the creation of on-scene risk assessment tools based on specific fire factors to assist company officers and incident commanders. (#17)	High
Conduct research into establishing safe and reliable aircraft operations in the wildland-urban interface. (#41)	Medium
Conduct research on cleaning methods for firefighter protective clothing, including potential impacts on the protective properties and useful life of the clothing, and determining effectiveness of removal of suspected carcinogens and other contaminants. (#33)	Medium
Conduct research on enhanced dermal protection provided by firefighter structural protective clothing, particularly as it relates to reducing exposures to known and suspected carcinogens. (#19)	High
Conduct research on how science can improve wildland firefighting training, tactics and response to reduce fatalities, injuries and unintended outcomes. (#20)	High
Conduct research on the effectiveness of alternative implementation strategies and policies for health and wellness programs. (#45)	Low
Conduct research to make improvements in the survivability of fire apparatus crashes. Conduct research related to anthropometric and ergonomic challenges in fire apparatus construction and arrangements that lead to frequent head and musculoskeletal injuries. (#50)	Medium
Continue progress toward the development and refinement of enhanced data systems (such as N-FORS) across all fire service domains. (#2)	High

Continue research into operational practices directed toward more effective tactics, improvements in firefighter safety and victim survivability and reductions in property losses. These studies should specifically address staffing and deployment, fire dynamics research and victim survivability. The focus should include high-rise residential and commercial buildings, private dwellings, multiple unit residential occupancies, strip malls, taxpayer buildings and warehouses. (#21)	High
Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks. (#47)	High
Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds. (#35)	Medium
Determine the necessary components to be included in the educational process for incident commanders, taking into account risk management, tactics, operational concerns and an acceptable knowledge base. (#53)	Low
Develop a centralized data warehouse and common data elements to facilitate research related to wildland firefighting. (#3)	High
Develop a physical fitness risk assessment tool for wildland firefighters. (#46)	Low
Develop a user-friendly technological accountability system for use on the fireground. (#51)	Medium
Develop methods to evaluate and quantify the direct and indirect economic impacts of fire service response and operations on property, people and the environment. (#37)	Medium
Establish a center for best practices for data collection and analysis. Identify and catalog data sources and technology formats that are relevant and beneficial for the fire service. (#10)	Medium
Evaluate behavior modification strategies that will lead to lasting cultural changes resulting in improvements in data collection and use. (#5)	High
Evaluate existing ballistic protection options (including helmets) for firefighters and EMS responders. As indicated by findings, develop new options. (#52)	Medium
Evaluate the impact of modern and evolving building technology (i.e. green buildings, solar and battery storage systems) on fire service operations. Create a knowledge base for incident commanders, company officers and firefighters to support operational safely and proficiently. (#38)	Medium
Identify and develop methods to capture operational data on fireground performance, mental resiliency, effective communications and operational benchmarks. (#6)	High
Identify and make use of traditional and non-traditional data to supplement, update and enhance fire service programs, including fire suppression and emergency operations, public education, fire prevention and community risk reduction efforts. (#7)	High
Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway). (#39)	Medium

Identify respiratory contaminants and determine the potential adverse health outcomes associated with wildland and wildland-urban interface fire operations. Also, determine the adequate respiratory protection for wildland firefighters. (#25)	High
Improve local data collection in order to positively impact efficient service delivery, professional development and organizational health. (#8)	High
Measure the fire growth rate in new homes which are built to modern energy codes and specifications and furnished with contemporary fire loads. Simulate and evaluate escape times based on the realistic capabilities of individuals. (#44)	Low
Research the application of unmanned aerial vehicles for the fire service. (#54)	Low
Research the development of technology, tactics and response standards in the wildland-urban interface. Include PPE requirements for all responders. (#48)	High
Research the effectiveness of alternative learning mechanisms in order to identify and develop the best firefighter training delivery system(s) for strategic, tactical and task level operations. (#40)	Medium
Research the impact of communication failures with portable radio systems and devices as a contributing factor in firefighter injuries and fatalities. Address alternative radio system configurations to ensure reliable in-building radio communications. Also, examine potential improvements in radio construction, ergonomics and the ability to interface portable radios with other technologies to track firefighters in the fire environment. (#27)	High

Appendix P: 2015 Recommendations – Tools and Equipment

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Conduct a study of the life span of PPE. (#16)	High
Conduct research based on fire dynamics to identify best practices at the strategic, tactical and task levels for firefighting operations in new and existing commercial and residential structures. The research should include the creation of on-scene risk assessment tools based on specific fire factors to assist company officers and incident commanders. (#17)	High
Conduct research on cleaning methods for firefighter protective clothing, including potential impacts on the protective properties and useful life of the clothing, and determining effectiveness of removal of suspected carcinogens and other contaminants. (#33)	Medium
Conduct research to make improvements in the survivability of fire apparatus crashes. Conduct research related to anthropometric and ergonomic challenges in fire apparatus construction and arrangements that lead to frequent head and musculoskeletal injuries. (#50)	Medium
Continue research into operational practices directed toward more effective tactics, improvements in firefighter safety and victim survivability and reductions in property losses. These studies should specifically address staffing and deployment, fire dynamics research and victim survivability. The focus should include high-rise residential and commercial buildings, private dwellings, multiple unit residential occupancies, strip malls, taxpayer buildings and warehouses. (#21)	High
Continue research on firefighter health, injury and diseases related to chronic and repeated exposures to the risks of emergency incidents and the fire service work environment. The research should include encompass all disciplines including wildland and wildland-urban interface. (#22)	High
Continue research on firefighter health, injury and diseases related to the risks of acute exposures that may result from emergency incidents. (#23)	High
Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks. (#47)	High
Determine the appropriate level of respiratory protection for use during overhaul operations including the use of air monitoring instruments to measure thresholds. (#35)	Medium

Determine the necessary components to be included in the educational process for incident commanders, taking into account risk management, tactics, operational concerns and an acceptable knowledge base. (#53)	Low
Develop a user-friendly technological accountability system for use on the fireground. (#51)	Medium
Develop methods to evaluate and quantify the direct and indirect economic impacts of fire service response and operations on property, people and the environment. (#37)	Medium
Evaluate existing ballistic protection options (including helmets) for firefighters and EMS responders. As indicated by findings, develop new options. (#52)	Medium
Evaluate the impact of modern and evolving building technology (i.e. green buildings, solar and battery storage systems) on fire service operations. Create a knowledge base for incident commanders, company officers and firefighters to support operational safely and proficiently. (#38)	Medium
Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway). (#39)	Medium
Research the application of unmanned aerial vehicles for the fire service. (#54)	Low
Research the effectiveness of alternative learning mechanisms in order to identify and develop the best firefighter training delivery system(s) for strategic, tactical and task level operations. (#40)	Medium
Research the impact of communication failures with portable radio systems and devices as a contributing factor in firefighter injuries and fatalities. Address alternative radio system configurations to ensure reliable in-building radio communications. Also, examine potential improvements in radio construction, ergonomics and the ability to interface portable radios with other technologies to track firefighters in the fire environment. (#27)	High

Appendix Q: 2015 Recommendations – Wildland Firefighting/Wildland-Urban Interface

RECOMMENDATIONS (in alphabetical order)	PRIORITY LEVEL
Assess the impact/influence of the adoption/enforcement of codes on the economic impact of wildland-urban interface fires. Consider the impact on both wildland to urban and urban to wildland fire transitions. Examine the impact on fire ignitions and loss. (#31)	Medium
Conduct research into establishing safe and reliable aircraft operations in the wildland-urban interface. (#41)	Medium
Conduct research on how science can improve wildland firefighting training, tactics and response to reduce fatalities, injuries and unintended outcomes. (#20)	High
Continue progress toward the development and refinement of enhanced data systems (such as N-FORS) across all fire service domains. (#2)	High
Continue research on firefighter health, injury and diseases related to chronic and repeated exposures to the risks of emergency incidents and the fire service work environment. The research should encompass all disciplines including wildland and wildland-urban interface. (#22)	High
Continue research on firefighter health, injury and diseases related to the risks of acute exposures that may result from emergency incidents. (#23)	High
Continue to employ fire modeling and full scale re-creations of specific incidents that resulted in firefighter injuries and deaths to identify contributing factors and recommended changes in strategy, tactics and tasks. (#47)	High
Create a searchable database of community risk reduction programs that have been identified as best practices in communities and/or states. (#12)	Low
Determine the incidence and frequency of occupational diseases/illness/injury/conditions in underrepresented groups and those with unique exposures. (#9)	Medium
Determine the necessary components to be included in the educational process for incident commanders, taking into account risk management, tactics, operational concerns and an acceptable knowledge base. (#53)	Low
Develop a centralized data warehouse and common data elements to facilitate research related to wildland firefighting. (#3)	High
Develop a physical fitness risk assessment tool for wildland firefighters. (#46)	Low
Develop a user-friendly technological accountability system for use on the fireground. (#51)	Medium

Develop methods to evaluate and quantify the direct and indirect economic impacts of fire service response and operations on property, people and the environment. (#37)	Medium
Identify and develop methods to capture operational data on fireground performance, mental resiliency, effective communications and operational benchmarks. (#6)	High
Identify and make use of traditional and non-traditional data to supplement, update and enhance fire service programs, including fire suppression and emergency operations, public education, fire prevention and community risk reduction efforts. (#7)	High
Identify contributing factors to firefighter injuries and fatalities related to non-fireground events (i.e. EMS, special operations and roadway). (#39)	Medium
Identify respiratory contaminants and determine the potential adverse health outcomes associated with wildland and wildland-urban interface fire operations. Also, determine the adequate respiratory protection for wildland firefighters. (#25)	High
Research the application of unmanned aerial vehicles for the fire service. (#54)	Low
Research the development of technology, tactics and response standards in the wildland-urban interface. Include PPE requirements for all responders. (#48)	High
Research the effectiveness of alternative learning mechanisms in order to identify and develop the best firefighter training delivery system(s) for strategic, tactical and task level operations. (#40)	Medium
Research the impact of communication failures with portable radio systems and devices as a contributing factor in firefighter injuries and fatalities. Address alternative radio system configurations to ensure reliable in-building radio communications. Also, examine potential improvements in radio construction, ergonomics and the ability to interface portable radios with other technologies to track firefighters in the fire environment. (#27)	High
Research total worker health of the wildland firefighter population to improve health and wellness. (#11)	Medium

National Fallen Firefighters Foundation
Post Office Drawer 498
Emmitsburg, Maryland 21727
301.447.1365 • 301.447.1645 fax
www.firehero.org
firehero@firehero.org