Journal of the

WILDFIRE CONSERVANCY

Volume 1 • Issue 1
2024

WildfireConservancy.org

About the Journal

The Journal of the Wildfire Conservancy is a scientific, peer-reviewed journal supported by the Wildfire Conservancy and the Wildfire Science and Urban Interface Program at California State University San Marcos. We publish a variety of new and innovative papers, articles, and manuscripts that help to advance our mission of research, education, and outreach, with a focus on wildfires and the wildland urban interface. The primary focus of the Journal is to highlight research that can have practical application and implementation by company officers, firefighters, decision makers, and legislators, to bridge the divide between science and policy. Contributions to this Journal should focus on good science and include practical applications for that science. The Journal contributes to the advancement of three specific areas of emphasis:

- Improving Firefighter Health and Safety
- Advancing Attack Effectiveness
- Promoting Community Resilience and Awareness

The Journal publishes articles focused on basic and applied research in an open-access, online publication that supports innovation and progress toward the advancement of wildland and urban interface fire issues. All content is free to the public to download, copy, and print; this supports our focus of bringing science to the practitioners and decision makers. Articles may include links to informative videos, training modules, data, and supporting posters/brochures that fire departments, local, state, federal, and tribal governments, organizations, and the public can download and use as tools for advancing training and understanding.

As an open-access, online journal, authors are not charged any fees for publication, and the submittal, review, editing, and production are efficient and flexible. We accept articles for the following:

- Original Research Papers
- Literature Reviews and Annotated Bibliographies
- Conference Proceedings
- Opinion Articles and Book Reviews
- Legislative Updates and Analysis
- Student Research Papers and Posters

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Published on Behalf of: California State University San Marcos and The Wildfire Conservancy

THE WILDFIRE CONSERVANCY ANNUAL SYMPOSIUM PROCEEDINGS 2024

Matt Rahn, Ph.D., M.S., J.D., Kelcey Stricker, DrPH, M.S., George Broyles, M.N.R., Terry McHale

Ten years ago, a group of individuals responsible for the creation and development of the Wildfire Conservancy hosted a symposium in Sacramento: "A Comprehensive View on the Future of Fighting Wildfires by a Team of Experts."[1]

The goal was simple. At a time when wildfires were becoming more common, more devastating in California, and engendering greater fear and society cost, experts from the federal, state and local levels came together to address key issues related to land management, the environment, firefighter staffing, and safety.

A conclusion that was virtually universal in the making was that urbanization and land use change has profoundly impacted the California landscape. Our changing climate has intensified the risk of wildfires, and exacerbating the situation was that we were easily a generation behind the advancements made in fighting structure and urban fires. In order to swiftly advance change, we first needed to acknowledge that our understanding, and nomenclature were outdated. Fires in California (and nationally) are no longer "just" wildland fires, with homes, business, and infrastructure at constant and serious risk. Furthermore, these incidents are no longer occurring in discrete times of the year that used to signify a "fire season." These fires are occurring year-round, with some of the largest and most devastating recent incidents occurring during the winter months. The fires were disrespectful of boundaries and burned from rural spaces with a ferocity that devastated urban environments. Entire towns were reduced to moonscapes. Today, we regretfully acknowledge that majority of our fires are Wildland Urban Interface (WUI) incidents, and the fire season is now a "fire year."

In America Burning (1973), the Nixon-era Report of the National Commission on Fire Prevention and Control has fundamentally changed the way we fight fires in the U.S.[2] Several key recommendations boldly stated what has become obvious:

- There needs to be more emphasis on fire prevention
- The fire services need better training and education
- Americans must be educated about fire safety
- In both design and materials, the environment in which Americans live and work presents unnecessary hazards
- The fire protection features of buildings need to be improved
- Important areas of research are being neglected

Following the recommendations of America Burning, the country in the following decades experienced remarkable decreases in property losses, lives lost, injuries, and total number of structure/urban fires, all while the country was vastly growing in population and infrastructure. Unfortunately, during that same period of time, all metrics related to wildland/WUI fires dramatically moved in the opposite direction.

Taking a deliberate cue from America Burning (1973), the 2014 symposium made sim-

ilar suppositions about the status of wildland/WUI fires in California, emphasizing the important role that research and education can have on advancing an industry. The outcome of that first meeting provided direction for the past ten years, culminating in the establishment of the non-profit research foundation now known as the Wildfire Conservancy in 2019, and a new bachelor's degree program at California State University San Marcos: Wildfire Science and the Wildland Urban Interface in that same year.

Having addressed many of the recommendations made by the 2014 symposium, the Wildfire Conservancy hosted the 2024 Annual Symposium, again in Sacramento, California, with the goal of highlighting the role that the Conservancy now serves in facilitating new projects, research, and educational outreach aimed at advancing wildland/WUI firefighting, with an emphasis on firefighter health and safety, attack effectiveness, and community resilience.

The 2024 Symposium is as much a summary of an update on the last decade of work as it is a roadmap of where we go from here. It identifies key areas of need, gaps in information, and future direction for California.

Executive Summary

This year's Annual Symposium of the Wildfire Conservancy included experts from around the United States and California. These leaders in their field are working on critical projects that directly or indirectly relate to the work of the Wildfire Conservancy and our key organization and agency partners.

Day one of the Symposium was focused on firefighter health and safety. The discussion encompassed several ongoing projects related to wildland/WUI firefighter cancer, personal protective equipment (PPE), cultural and behavioral barriers, and wellness. Presentations were made from agency experts in both science and policy, discussing the challenges and opportunities related to advancing safety, code, and standards.

The second day was focused on topics related to community resilience. The Conservancy brought in experts from the housing development industry, advanced materials experts for construction and design, representatives of the insurance industry, and representatives from the California Legislature (both Assembly and Senate). Through presentations and panel discussions, subject matter experts addressed California's crisis related to wildland/WUI fires, and the urgent steps needed to break this devastating cycle.

At the end of each day, a facilitated discussion among all participants and experts focused on addressing key concerns and emerging issues, gaps in information and understanding. Recommendations for future direction and work were consequential. Those results are presented herein and summarized below.

Gaps in Information and Key Priorities

Firefighter Health and Safety

- We need to advance our understanding of wildland/WUI cancer risk and identify scientifically and medically valid interventions.
- Interdisciplinary, holistic, long-term, longitudinal studies are needed that bring together topics like nutrition, exercise, sleep, PPE, decontamination, among others.
- A specific focus on reproductive health impacts from wildland/WUI firefighting is needed.
- Reducing dermal exposure risk requires additional advanced research on the effectiveness and protocols for proper decontamination, specific to various types of contaminants
- Reducing respiratory exposure risk requires additional advanced research on interventions and post-exposure treatments specific to different types of contaminants

- We need to increase research response to incidents, improving data collection, and gaining access to firefighters and incidents at critical times of exposure and risk
- We need to evaluate the utility of biometrics for individual firefighter awareness and incident command related to factors like heart rate, core temperature, hydration status, blood oxygen levels, and key exposure metrics to improve individual decision-making and incident-level awareness and intervention
- Retired Firefighters are an important and overlooked component of wellness and health research that can potentially provide significant and immediate insight into long-term results of career-level exposure and health/safety outcomes
- Leadership is critically important to implementing lasting change – following behaviors modeled by leadership is a core part of the fire industry culture– the example they set can make a significant difference
- Behavioral health research is critically important not just in addressing issues of post-traumatic stress, depression, anxiety, addiction, and suicide, but also in its role in identifying cultural and behavioral barriers to change in the fire service, and the adoption, implementation, and acceptance of new protocols, policies, and tools.
- We need to translate recommendations, science, data, and information across different platforms like social media, text messaging, and other formats to reach different generations of firefighters; it has to be informative, compelling, memorable, and succinct
- Adaptive management and monitoring must become a core tenet of change in the fire service – too often a change in protocols, policy, or technology can lead to unintended and negative outcomes – as changes are implemented, programs should be in place to assess the short- and long-term effects

Community Resilience

- Education is crucial for enhancing community resilience, along with participation and buy-in from the individual parcel to the community level
- Sustaining compliance with planning, design, and building codes presents a significant challenge for cities, counties, insurers, homeowners associations, and other stakeholders
- All mitigation strategies must be evidence-based to ensure their effectiveness and should be verified in a lab and field tested
- For lack of a better term, a "Fire Star" Program aimed at promoting fire resilience in building construction and retrofitting, akin to the goals of those other existing programs like LEED or Energy Star may help encourage homeowners, builders, and communities to adopt practices that reduce the risk of WUI/wildland fires
- Evaluating materials and products used in construction and development should also include an assessment of the potential byproducts of combustion and issues related to community and firefighter exposure risk
- California should have an annual "Legislative Bootcamp" that brings together key legislators, committee members, and staff for a non-partisan symposium that is led by scientific and subject matter experts for improved education, outreach, and decision-making
- The California Legislature should adopt a fellowships/internship program that places firefighters, academics, researchers, students, and subject matter experts in strategic offices and committees to help advance collaboration, understanding, and problem solving in California
- Establishing an annual Wildland Urban Interface (WUI) Day as a preparedness event designed to enhance awareness and readiness for wildland and wildland urban interface fire to establish a continuous and coordinated outreach

program that equips firefighters, municipalities, state, federal, and tribal agencies, as well as community members, stakeholders, and businesses with essential knowledge and tools related to wildfire prevention and crisis management, focused on educational workshops, drills and simulations, firefighter training, community engagement, and collaboration

A detailed list of gaps and priorities are provided in the concluding sections of this report.

The following agencies and organizations attended the Symposium, and participated in the presentations and discussions:

- 3M
- CAL FIRE
- CAL FIRE Local 2881
- CAL FIRE
- Cal Poly San Luis Obispo
- Cal/OSHA Research and Standards Office
- California Department of Public Health, Environmental and Emergency Preparedness
- California Professional Firefighters
- Cornerstone Research Group
- CR&R Inc.
- DuPont Personal Protection
- First Respire
- Grassroots Wildland Firefighters
- International Association of Fire Fighters
- James Hardie Building Products
- Los Angeles County Fire Department
- Mystery Ranch Backpacks
- National Fallen Firefighters Foundation
- North Carolina State University
- National Institute for Occupational Safety and Health (NIOSH)
- Pala Band of Indians
- Personal Insurance Federation of California
- Snohomish County Fire District 4
- University of California Davis
- Underwriters Laboratory Fire Safety Research Institute
- University of Arizona
- U.S. Department of Agriculture, Forest Service
- USFS Lassen Interagency Hotshot Crew

WILDLAND/WUI FIREFIGHTER HEALTH AND SAFETY: THE FIREFIGHTER PERSPECTIVE

Joe Ten Eyck
Wildfire/Urban-Interface Fire Programs Coordinator
International Association of Fire Fighters CAL FIRE Firefighter (retired)

When it comes to our firefighters, nothing matters more today than the quality of life during active duty, and retirement. To be certain, wildland and WUI firefighting has come a long way in the past century, but we cannot know where we are going, if we don't know where we have been. A hundred years ago, wildland firefighting used to be done off the back of a truck, wearing only jeans and a t-shirt, carrying simple hand tools and shovels, wearing a bandana to protect the lungs. Fifty years ago, most California state firefighters were working a 106-hour duty week as an acceptable schedule, not including longer deployments on large wildfires. Today, many material and technological advancements, changes in tactics and strategies, and remarkable air and ground resources have vastly changed the industry for the better. However, cancer risk, health concerns, mental health challenges, and exhausting schedules reminds us there is much more to be done.

While significant strides are being made to advance the personal protective equipment for modern firefighters, cost factors and convenience mean many men and women on the frontline are still wearing a bandana for respiratory protection. And while just this past legislative cycle, the new standard for CAL FIRE is a 66-hour work week, there are still firefighters deployed to incidents for days, weeks, or months at a time. Today, our firefighters are dying of cancer, cardiac events, and suicide at rates never imagined. The job has become so much larger, and burdensome than it ever was historically, with literally millions of lives relying on their bravery and success. Our experts here today, and our Symposium participants are being asked to tackle some of the most important issues facing our state and nation, in a perpetual effort to improve the quality of life for our firefighters and our community.

The backbone of a viable fire service relies on a significant investment in land management, fuels treatment, initial attack and suppression, and enough resources and equipment to get the job done. Additionally, we rely on our partners in science, research, and education/outreach to help answer critical questions, provide the data and analysis needed to make informed decisions, and translate complex information into educational and outreach programs for our firefighters, decision-makers, and community members. This Symposium is an important step in creating a legacy in California and beyond, ensuring that future generations of firefighters and community members are more resilient, safe, and healthy.
largest and most devastating recent incidents occurring during the winter months. The fires were disrespectful of boundaries and burned from rural spaces with a ferocity that devastated urban environments.

THE WILDFIRE CONSERVANCY

RESPIRATORY PROTECTION, DERMAL DECONTAMINATION, AND PERSONAL PROTECTIVE EQUIPMENT

Dr. Bryan Ormond[1], Dr. Matt Rahn[2], and Dr. Kelcey Stricker[2]
[1]*Textile Protection and Comfort Center, Textile Engineering, Chemistry, & Science Department, Wilson College of Textiles, North Carolina State University*
[2]*The Wildfire Conservancy, Sacramento, California*

Introduction

Wildland and WUI firefighters experience two distinct type of occupational exposures: dermal and respiratory. Working on wildland/WUI fires exposes firefighters to a myriad of compounds, chemicals, heavy metals, and other substances that are toxic, hazardous, and often carcinogenic. Much of the current research focuses on how personal protective equipment (PPE) can help reduce risk.

Recognized as the last resort in the Hierarchy of Controls, the use of PPE is the last line of defense in protecting a worker from risk or hazardous environments (Figure 1). Dr. Bryan Ormond, research professor with North Carolina State University, Wilson College of Textiles also considers PPE a study of "trade-offs." The wildland garments used today do not provide any significant protection from skin exposures. While textiles can be created to reduce and/or eliminate those risks, that same gear still must provide thermal protection, thermal comfort, address physiological burdens, and heat stress for those wearing it. Finding a balance that works is pushing the limits of research and development and creating a difficult conversation about trade-offs in PPE. Independent research on PPE can help fire agencies make informed, science-based decisions that weigh the costs and benefits of the PPE while also considering the cultural and behavioral barriers to adoption, acceptance, and implementation – not an insignificant task.

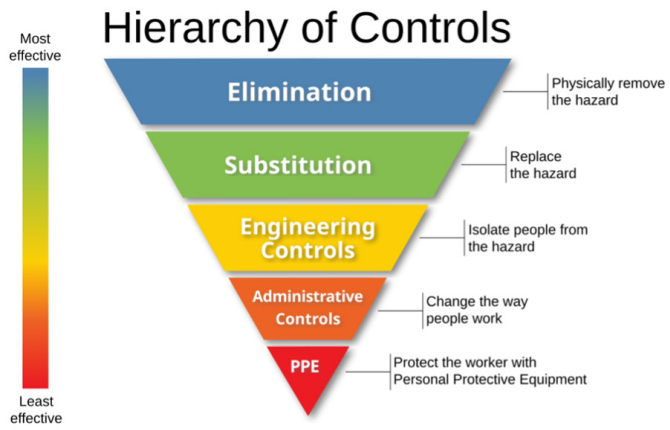

Figure 1. Hierarchy of Controls (U.S. National Institute for Occupational Safety and Health).

Dermal Exposure

We are currently testing various types of new fabric and garments that have particulate blocking properties. Regardless of whether we are testing for fabrics or respiratory devices, it is important to understand the difference between particulates and vapors and how each carry with them different constituents of concern, and different pathways of exposure.

Particle blocking fabrics are showing significant promise, but future PPE would need to be tested for both particle and vapor standards if we are truly moving toward a higher standard of protection.

Key questions to understanding dermal exposures include:

- Is dermal exposure significant enough to cause negative health outcomes?
- Can vapors and particulates penetrate PPE?
- What carcinogenic compounds can reach a firefighter's skin, especially under working conditions?
- How do fireground factors (temperature, humidity, etc.) affect absorption?

A "one size fits all" approach to PPE is inadequate, as new designs may introduce different risks. Reducing exposure to one compound might increase exposure to another, complicating mitigation efforts. Combatting single exposures often requires unique and complex solutions; multiple exposures exponentially convolute that complexity.

A crucial, overlooked aspect of risk management and the hierarchy of controls is decontamination. Research is ongoing into effective cleaning methods and detergents for reducing contamination on both PPE and skin after an incident. While products targeting wildland firefighters are marketed as having decontamination properties, rigorous independent validation is often lacking. Future priorities should focus on effective decontamination protocols and practices based on sound science to guide decisions. The goal is to help firefighters, policy makers, and agencies make informed decisions based on the best available science, and not allow lack of understanding or misinformation to become a barrier to implementation of protective measures.

Respiratory Exposure

While the respiratory system has some innate barriers, it is still vulnerable to fire-related compounds. The lungs are much more susceptible to harmful exposures than the skin (dermis), making respiratory protection essential for firefighters. The lungs, at their deepest levels, are only 1-2 cells thick between the air we breathe in and the bloodstream. In stark contrast, of the routes of exposure for a human, the mucus membrane of the eyes is 0.0002 m^2, the skin is 1.5-2.0 m2, while the respiratory system contains 50-100 m^2. If we are not focusing on respiratory protection, we are doing a disservice to firefighters.

The hard reality is that very little respiratory protection exists for those fighting wildland and WUI fires--you're not coming down from 95% protection, you're coming up from 0%. Today, no standards, products, or policies have been established that effectively mitigate respiratory risk. Most firefighters are still following a century-old tradition of using a bandana (e.g. a permeable piece of fabric) while working in some of the most toxic, hazardous, and carcinogenic conditions imaginable. We expect firefighters to have respiratory protection, especially when battling structure or vehicle fires. Modern WUI fires regularly have both structures and vehicles burning, in addition to vegetation. However there is nothing commonly being used for wildland/WUI firefighter protection. No respiratory device has ever been submitted for certification to the existing NFPA 1984 standard. The main reason cited by manufacturers is supposedly the lack of a perceived market for a wildland respiratory device due to the absence of a requirement from firefighting management agencies. In other words, firefighting agencies are not requiring wildland/WUI respiratory protection for their firefighters and manufacturers view that as a lack of market for a product.[3]

To develop an appropriate respiratory protective device for wildland/WUI firefighting, testing must occur in realistic conditions to assess PPE efficacy under work-related stresses. Current laboratory testing is evaluating the effectiveness of various devices, from a simple bandana to a full-face powered air respirator (PAPR). However we must also test these devices under more realistic conditions and work environments. We intuitively know that respiratory protection devices are not providing the same levels of protection seen in the lab when under various types of work stress. Testing

under realistic situations will help us understand how they work with the rigors of movement, heat, sweat, humidity, water, dirt, mud, soot, ash, and smoke.

Not all PPE is going to function under the rigors of wildland/WUI firefighting, be compatible with existing PPE, or be capable of keeping pace with the demands of high respiratory rates, clear communication, and unimpaired vision. Further, it is imperative to understand how various devices may impact the firefighter's physiology (e.g. core temperature, oxygen saturation, heart rate, etc.). Including the full spectrum of respiratory protection products currently available or emerging in the marketplace will help us to understand how they work, and what kinds of realistic, real-world protection we can expect. This will also assist in informing future design and development of novel PPE.

Agencies often hesitate to adopt new devices or policy unless they meet high standards, but we should not overlook those devices that can provide measurable exposure reduction. Progress shouldn't be hindered by the quest for perfection.

THE WILDFIRE CONSERVANCY

AN UPDATE ON WILDLAND AND URBAN INTERFACE FIREFIGHTER WELLNESS AND SAFETY

Chief Jeremy Lawson, Chief Warren Parrish
California Department of Forestry and Fire Protection (CAL FIRE)

Introduction

Wildland and WUI firefighters experience two distinct type of occupational exposures: dermal and respiratory. Working on wildland/WUI fires exposes firefighters to a myriad of compounds, chemicals, heavy metals, and other substances that are toxic, hazardous, and often carcinogenic. Much of the current research focuses on how personal protective equipment (PPE) can help reduce risk.

Recognized as the last resort in the Hierarchy of Controls, the use of PPE is the last line of defense in protecting a worker from risk or hazardous environments (Figure 1). Dr. Bryan Ormond, research professor with North Carolina State University, Wilson College of Textiles also considers PPE a study of "trade-offs." The wildland garments used today do not provide any significant protection from skin exposures. While textiles can be created to reduce and/or eliminate those risks, that same gear still must provide thermal protection, thermal comfort, address physiological burdens, and heat stress for those wearing it. Finding a balance that works is pushing the limits of research and development and creating a difficult conversation about trade-offs in PPE. Independent research on PPE can help fire agencies make informed, science-based decisions that weigh the costs and benefits of the PPE while also considering the cultural and behavioral barriers to adoption, acceptance, and implementation – not an insignificant task.

In an update provided by CAL FIRE, representatives from both the Safety and Wellness divisions for CAL FIRE discussed the status and future plans for California's firefighters. The focus is largely on prevention, recovery, and resilience.

Wellness Programs

Noting the robust growth of areas related to physical fitness and mobility/stability, today's efforts are aimed at ensuring firefighters are given the training and tools based on modern principles of functional fitness – a core tenet of training the body to prepare for the work conditions they encounter.

Preparation and recovery from the rigors of firefighting is also directly related to hydration and nutrition. We have seen a lot of change in recent years related to the kinds of food firefighters are consuming not only at the station, but at basecamp and on incident. Taking a more holistic approach to firefighting means incorporating screening and prevention programs as early as possible. And of course, there is a significant focus today on the mindset of our firefighters, and increased efforts to improve access to behavioral health resources and information. CAL FIRE discussed the importance of strategic planning noting that their Health and Wellness Model is being updated this year and undergoes regular updates roughly every five years, ensuring the ability for the department to stay at the forefront of the industry.

Critical to these updates and direction is the role that research and development plays in the modern fire service. Not only has CAL FIRE increased its integration of Research and Development (R&D) programs, but it also acknowledged the significant value brought by their many partners and collaborators (many of whom were in the room that day). Today, R&D is being driven by strategic planning, priorities, and needs identified by CAL FIRE itself. Partnering for innovation and technology is critical across so many aspects of what the fire service does today, from communications, mapping/modeling, planning, and even health, safety, and wellness.

However, even with the best R&D programs, strategic planning, and programs, effectively sharing information to employees remains a serious objective. Meeting this challenge – CAL FIRE and other agencies have evolved not only the way in-person training and education is conducted, but they have also significantly invested in digital outreach and communications across a variety of platforms. Recognizing that their employees all have different ways of learning, consuming information, and accessing departmental updates, CAL FIRE continues to champion new and novel ways of outreach and education. It's not just about creating new policy or standards, but also about explaining why it is important. Indeed, significant research has been devoted to simply showing how a deeper understanding and appreciation of an issue leads to higher rates of acceptance, adoption, and long-term implementation.

Adaptation and Resilience

One of the key topic areas focused on how the fire service can adapt to change, new tools, technology, policy, PPE, or whatever they may encounter. Awareness of the barriers to change is a critical first step, and as a result, CAL FIRE is changing the way they do business as an agency. This means asking the hard questions like, "Are we effectively helping our employees, or are we properly trained internally to help our employees?" Data and expert information becomes critical, allowing the department to evaluate whether the services provided to the firefighters is effective. This is particularly important in emerging areas like behavioral health. While significant data and research has been done on the mental and behavioral health of high-risk, high-stress occupations, firefighting remains under-represented in this arena. CAL FIRE is working hard to change this, and ensure that through collaborations and strategic planning, effective and informed change can occur.

The CAL FIRE Strategic Plan has several main objectives:

- Utilize technology and define innovative solutions to better serve employees
- Identify, research, and develop initiatives that meet strategic goals
- Analyze program development through internal and external partnerships (with independent, unbiased research reinforced through scientific and statistical rigor)
- Empower employees and families with mitigation measure information, tools, and resources to live healthier lives
- Building relationships with labor and making sure both sides are working together on these issues

Safety Programs

Much like Wellness, Safety programs rely on subject matter expertise – true expertise based on current and best available information, science, and medical information. A lot of time and effort is spent responding to new regulations from agencies like the California Division of Occupational Safety and health (Cal/OSHA), and the methodical advancement of standards for employees.

Efforts are being made to improve the partnership between regulatory and standards agencies and organizations, and the regulated agencies for setting standards and

communicating the costs, benefits, logistics, or other factors associated with those standards. This requires a collaborative approach to identifying future needs for regulations and standards.

This requires subject matter experts both internal and external to assist in this process, making this more of a partnership in change rather than simply reactionary. This process should also include R&D, manufacturers, and other stakeholders to ensure that everyone is working together. As the largest fire department in the nation, CAL FIRE is uniquely positioned to help drive state and national standards, regulations, policies, and procedures. Further, CAL FIRE works across one of the largest, most diverse states as an all-risk, all-response agency, providing a unique opportunity to conduct research that can be translated nationally.

Collectively, everyone agreed that the priority right now for safety is occupational exposure risk and the health and safety of our firefighters. It is undeniable that incidence of cancer and other health effects have dramatically increased for firefighters, specifically related to wildland/WUI fires.

Much like Wellness, implementing new Safety measures is not just about training. It's also about increasing education and awareness – for the firefighters. This requires a concerted effort and investment – there needs to be a commitment to the infrastructure that will ensure advancements in safety are properly integrated into programs and departments. Further, this must be a collaboration between labor, management, and decision-makers, to ensure that those who make the budget decisions know that this is a critical aspect to success. If California is going to take health and safety, cancer risk, behavioral health, or other priorities seriously, this will require more than just lip service, it will demand a true fiscal and temporal commitment to make this work. This cannot just be an investment in the uniformed staff, but also in the family and network of people that support those firefighters. There needs to be an inclusive effort that engages the community in education and resources that can help firefighters.

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WILDLAND FIREFIGHTER EXPOSURES: UPDATE FROM THE FIRE FIGHTER CANCER COHORT STUDY (FFCCS)

Jeff Burgess, MD, MS, MPH
Center for Firefighter Health Collaborative Research, Mel and Enid Zuckerman College of Public Health, University of Arizona

Several years ago, Dr. Burgess brought to California, CAL FIRE, and the Wildfire Conservancy the idea, infrastructure, and support necessary to conduct one of the largest prospective, longitudinal, cancer cohort studies on wildland firefighters in the nation. Established in July 2016 with funding from the Federal Emergency Management Agency (FEMA), the Fire Fighter Cancer Cohort Study (FFCCS) gathers nationwide data on firefighter health, including surveys, biomarkers, and exposure information related to cancer-causing substances. This partnership with the fire service aims to understand the health impacts of these exposures and prevent associated risks.

Similar to the Framingham Heart Study and Nurses' Health Study, the FFCCS has both primary and secondary goals for data collection. The long-term goal of the FFCCS is to track the health of 10,000 firefighters from multiple fire departments across the nation over a span of 30 years and to conduct community-engaged research with the fire service to advance firefighter cancer control and prevention. As a secondary goal, the FFCCS will also provide data for the evaluation and prevention of other health conditions that affect firefighters.

The Wildfire Conservancy is currently involved in the recruitment and long-term data collection efforts for the wildland firefighter subgroup within the FFCCS. With initial enrollment efforts beginning in 2021, and follow up data collection efforts currently underway, we are already learning so much about wildland firefighting.

What we currently about wildland firefighting is:

- Wildland firefighters are experiencing cross-seasonal changes in lung function[5, 6, 7]
- There are documented decreases in lung function associated with hours of firefighting activity[8] and exposure to wood smoke[9]
- Wildland firefighters experience elevated inflammation and oxidative stress among after both prescribed burns[10, 11] and wildfires[12]
- Wildland firefighter employment duration is directly associated with a history of hypertension and arrhythmias[13]
- There is a significant estimated increased risk of lung cancer mortality and cardiovascular disease[14]

In addition, wildland firefighters are being regularly exposed to a variety of toxic, hazardous, and carcinogenic substances while working on incidents. Of course, carbon monoxide is one of the most ubiquitous exposures on a fire incident.[15] This includes things like benzene, formaldehyde and polycyclic aromatic hydrocarbon (PAH) exposures.[16, 17, 18, 19] It is also well documented that these compounds are entering the body, with firefighters showing increases in urinary PAH metabolites after fires.[20, 21] As a result, firefighting is now considered a Group 1 carcinogen.[22]

Prevention is focused on reducing exposures, identifying effective treatment, and early detection. Two regulators of gene expression that we are investigating are DNA methylation and microRNA (miRNA). Un-

der normal conditions, miRNA help regulate gene expression, however, their activity can be affected by many things, including exposure to toxicants.

MiRNA regulate roughly 60% of all known genes.[23] Current and existing data from structure firefighters show long-term personnel have significantly worse miRNA regulation compared to new recruits. The miRNA that helps suppress tumors in areas of the brain, lungs, prostate, colon, and other areas are significantly altered in structure firefighters with many years of service, demonstrating that these firefighters are drastically impacted by occupational exposures in a way that is leading to an increased risk of these kinds of cancers.

Similarly, DNA methylation analysis shows significant differences in specific sites that are linked to cancers, immune function, neurologic function, and more. Many of these sites were associated with cumulative fire response and hours of exposures.[24] Likewise, epigenetic age acceleration is greater in incumbents than recruits but reduced with additional years in fire service. Those with more years of fire service are showing an accelerated "biological age" compared to their true chronological age, as measured through factors such as DNA methylation. These changes were also more strongly positively associated with "fire runs" (e.g. incident response) than "fire hours" (e.g. time on the job), providing additional evidence that it is occupational exposures and not other job factors, that are contributing to the heavy cancer burden seen in firefighters.[25]

For WUI firefighters, recent unpublished research is showing that there are significant increases in risk of many different types of cancers, but specifically tumor suppression and prostate cancer. Other changes included increased risk of bladder and breast cancer, impacts to wound healing, stem cells, and metabolic syndrome. This is why early screening and detection is so important. Understanding which risks firefighters should be most concerned with, and which exposures impact them the most, can help. However, there is a serious lack of information on wildland/WUI firefighting.

Traditionally, research on firefighters has focused on a predominantly male, White cohort. There have been tremendous insights and advancements in health and safety based on data collected on these populations. However, the fire service is increasingly diverse, both in population and in job duties, necessitating a concerted effort to diversify the study population and ensure it is representative.

We need to expanded current research, increase participation, and expand the diversity of firefighters included in these studies, not just in terms of age, race, and gender, but across the various duty types and positions. Additionally, we need to:

- Evaluate acute exposure to carcinogens during wildland and wildland-urban interface (WUI) responses using biological sampling (blood and urine)
- Measure biomarkers of chronic carcinogenic effect
- Test the effectiveness of interventions to reduce exposure and cancer risks

For example, we know that urinary PAH increase with wildland firefighting (e.g. response to incidents, controlled burns). Specifically, certain job types (e.g. suppression, firing operation, sawyer/swamper) appeared to be associated with higher exposure and corresponding increases in urinary PAH, most likely because of fuels and emissions from combustion engines and tools.

Current data collection efforts show that post-fire urinary PAH-OH concentrations are, in descending order, highest in firefighters working on WUI fires, then in prescribed fires, then in wildland. This makes sense given that a true wildland fire, devoid

of human products or materials, is based primarily on wood/plant-based combustion. Prescribed burns can use different types of accelerants and hydrocarbon fuels to facilitate burning, and often do not burn as hot, allowing for more products of incomplete combustion to be present (e.g. particulates, smoke, ash, etc.), hence increasing exposure compared to a wildland fire. A WUI fire, of course, contains all types of human made materials, chemicals, and compounds that are combusted, creating a complex suite of chemicals and exposures. That is not to say that smoke, ash, or soot from vegetation burns is safe—they definitely are not—only that WUI fires are significantly worse.

There is still a lot of variability in the data, and data collection efforts need to continue to better understand the preliminary results. A greater sample size will allow for understanding data spread, outliers, maximum values, and other summary measures. There are also many factors that affect wellness; miRNA, DNA methylation and other epigenetic factors can be positively affected by diet and exercise, stress reduction, sleep, overall physical fitness, and other controllable lifestyle factors. However, understanding to what extent wellness efforts can counteract the negative impacts of occupational and carcinogenic exposures in firefighters requires additional research. The effectiveness of lifestyle interventions on the firefighter population and their cancer burden remains a complex and open question.

THE WILDFIRE CONSERVANCY

WUI FIRE INSTITUTE UPDATE

Dr. Chris Dicus and Frank Frievalt
Cal Poly San Luis Obispo

The Wildland-Urban Interface (WUI) Fire Institute is a mission driven organization that seeks solutions to the Wildland Urban Interface fire problem through innovative research, training, and education to create safer and more fire resilient communities in California and the West. The goal of the Cal Poly WUI Fire Institute is to help create the most fire resilient communities in the world. With a mission of "learning by doing" Cal Poly has partnered with the Wildfire Conservancy and CAL FIRE to engineer and create science-based solutions to wildfire issues.

Unfortunately, trauma brings focus, which means there is no more important time than now to tackle the wildland/WUI issues for California and beyond. Our old approaches are clearly not working. And while it is critical to improve firefighter staffing, resources, and equipment, this isn't the only answer to a very complex problem. Nor will simply adding more prescribed fires and fuel reduction/thinning be the panacea for our communities. This is not a wildfire problem – it is a home/infrastructure problem and human problem. In many cases, a wildfire becomes a conflagration where homes and lives are lost. Decades of decision making has led us to our current situation.

Through interdisciplinary applied research, Cal Poly is working on a variety of projects that are aimed at answering some of the most critical problems facing our state. Our goal is to find new ways to collaborate on old and new ideas, while ensuring

that firefighters and agencies are integrated into the project. We are applying engineering and science-based solutions to fire management problems, including:

- Design and protection of the built environment
- First responder health and safety
- Social and economic factors
- Prescribed fire use in WUI environments

We are using Cal Poly's "Learn By Doing" educational approach to connect students into the process of developing and applying solutions. In turn, Cal Poly is providing advanced training for current and future workforce education, practitioners, regulators, and public preparedness and outreach.

THE WILDFIRE CONSERVANCY

INNOVATIONS IN CAL/OSHA RULEMAKING: PROTECTING FIREFIGHTERS DURING WILDLAND AND WUI OPERATIONS

Dr. Mike Wilson
California Department of Industrial Relations, Cal/OSHA, Research and Standards

As California's workplace safety and health agency, Cal/OSHA enforces general industry and construction safety orders and develops new rules to address gaps in worker safety and health. One of the key gaps we are focused on is the lack of respiratory protection for firefighters who are deployed to fight California's wildland and wildland urban interface (WUI) fires. This is a longstanding problem that Cal/OSHA is committed to solving, given that our state is the epicenter for wildland/WUI incidents nationally, and our firefighters are deployed every year into conditions that often involve high-intensity, long-duration exposures to smoke from vegetation and structural fires.

While Cal/OSHA is leading this effort as part of our worker safety mission, we are also responding to Assembly Bill 2146, sponsored by the California Professional Firefighters and carried by Assemblymember Nancy Skinner (D-Berkeley) in 2014, which requires the Department of Industrial Relations to assess whether Cal/OSHA's firefighter safety and health regulations reflect current NFPA standards. NFPA 1984 pertains to wildland/WUI respiratory protection, but to date, there is no respirator available on the market that meets and exceeds NFPA 1984 that is suitable for use by firefighters operating at these incidents. NFPA 1984 does not require that respirator cartridges be tested against smoke, for example, which introduces an unacceptable level of uncertainty from Cal/OSHA's perspective.

Cal/OSHA and the fire service are working together to advance W/WUI respiratory protection.

In approaching this problem, Cal/OSHA is interested first and foremost in the lived experience of firefighters. From our perspective, any new requirements pertaining to respiratory protection during wildland/WUI deployments must be built on a shared understanding of the practical demands of the job and the conditions firefighters face at these incidents. To be successful, we know that any new safety regulation for firefighters must be practical, flexible, meaningfully protective, and enforceable. To meet this objective, we're building partnerships within the California fire service agencies and departments, including with CAL FIRE, LA County Fire, the U.S. Forest Service, San Francisco, Oakland, Alameda County, San Diego, Los Angeles City and Orange County, and with representatives of the International Association of Firefighters (IAFF), California Professional Firefighters (CPF) and the California Fire Chiefs Association (CalChiefs). From Cal/OSHA's perspective, this community-based, participatory approach to rulemaking is the only way to craft a regulation that will meet the needs of the field while facilitating a generational advancement in firefighter safety and health.

Make no mistake: all smoke is toxic

In 2022, the National Academy of Sciences (NAS) released a report, The Chemistry of Fires at the Wildland-Urban Interface,

which summarized much of the scientific literature on the toxicity of smoke that's produced when wildland fires involve structures, vehicles and materials in the built environment. The report pointed out, for example, that when oriented strand board (OSB) burns, it releases a complex mixture of toxic combustion products that include fine particulate matter, formaldehyde, acrolein, hydrogen cyanide, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), isocyanates, hydrogen chloride, nitrogen oxides, and carbon monoxide. Each of these is linked to at least one serious health effect. Of course, OSB is just one of multiple products in a typical structure that produces toxic combustion products in a fire. The NAS report pointed to benzene, toluene and organophosphate flame retardants that are released alongside the substances listed above when acrylic clothing and residential furniture burns. Many, but not all, of these combustion products are also present in smoke from vegetation fires, which can become complicated when those fires burn through areas where pesticides or fertilizers have been applied, for example, or where trash has accumulated.

The occupation of firefighting is carcinogenic

Not surprisingly, based on an exhaustive review of the scientific literature, the International Agency for Research on Cancer (IARC) concluded in 2022 that there was sufficient evidence to classify the occupation of firefighting as carcinogenic. This is known as a "Group 1" carcinogen. IARC found sufficient evidence based on human cancer studies to draw a bright line between working as a firefighter and mesothelioma and bladder cancer. They found "limited evidence" for a link to colon cancer, prostate cancer, testicular cancer, melanoma of the skin, and non-Hodgkin lymphoma. IARC concluded that working as a firefighter meets five of the ten key characteristics of carcinogens; that is, it is genotoxic, induces epigenetic alterations, induces oxidative stress, induces chronic inflammation and modulates receptor mediated effects.

Long-standing barriers have thwarted the development of a wildland/WUI respirator

As we know from structure fires, respiratory protection is essential to protect firefighters from inhaling toxic products of combustion. The same can be said about exposures that occur during wildland/WUI operations. To date, however, a lack of demand by the fire service has been a key barrier to the development and deployment of respiratory protection during wildland/WUI incidents: no one is buying respirators for use at wildland/WUI incidents. This lack of demand, however, is understandable, because there is currently no respirator on the market that has been subjected to the kind of testing that simulates the conditions under which it will be used in the field. There is nothing on the market that we can be confident will perform as needed.

This lack of confidence is well-founded. As noted above, respirator cartridges are not subjected to smoke testing, for example, so it's unclear how well they would perform under smoky conditions, and how long they would perform effectively. Likewise, most respirator cartridges are not able to filter carbon monoxide (CO), which has raised concerns about the need to monitor CO levels among firefighters during wildland/WUI operations. It's also not clear if wearing a respirator could worsen heat stress and cardiovascular workload at a wildland/WUI incident, particularly during the hottest months of the year.

In the end, the lack of demand by the fire service, though well-founded, has meant that manufacturers have invested very little in developing a respirator that could be used effectively during wildland/WUI operations. This lack of industrial investment in research and development has meant that the technological innovation necessary for solving the challenges noted above has not

occurred at the scale and pace that's needed. Even where innovation has taken place with the support of the Federal government, such as with the promising powered air purifying respirator (PAPR) developed by TDA Design with the support of Homeland Security, the market is still unclear. Departments are not obligated to purchase these respiratory devices, and they're reluctant to invest heavily in a prototype device for which regulatory standards have not yet been established.

This has produced a long-standing and frustrating cycle for wildland/WUI respiratory protection, where (1) a lack of demand by the fire service produces (2) a lack of investment in research and development by manufacturers, which results in (3) a lack of viable wildland/WUI respirators on the market, which contributes back to the lack of demand by the fire service. Meanwhile, we're failing to meet the basic safety and health needs of firefighters, who continue to face wildland/WUI incidents without protection, while smoke conditions worsen. To break this negative feedback loop, the fire service will have to signal that it is ready to purchase and deploy a wildland/WUI respirator, should one become available on the market that meets a reasonable set of technical specifications.

Regulation as a driver of change

In Cal/OSHA's view, a new regulation is the most direct path to generating demand by the fire service for wildland/WUI respiratory protection. Requiring the fire service to provide effective respiratory protection to all firefighters deployed to wildland/WUI incidents raises the bar for all departments together and creates the market certainty that manufacturers need to invest in developing, testing and producing an effective wildland/WUI respirator. The regulation would need to include the technical specifications called for by the fire service.

Cal/OSHA previously employed this approach, known as "technology-forcing regulation," in drafting our regulation on bloodborne pathogens, section 5194 of the California Code of Regulations (CCR). We needed a device that was designed and engineered to prevent needle sticks among healthcare workers, but no such device existed on the market at the time. Rather than accepting those market conditions, we drafted the regulation to require healthcare employers to provide engineered injection devices "when they became available on the market." Being in California, one of the world's top five economies, this generated a surge of innovation among medical device companies, which soon introduced a number of engineered needle systems onto the market that effectively protected healthcare workers from needle sticks. Those devices are now the standard across the healthcare sector.

Based on this model, Cal/OSHA released a discussion draft in May, 2022 for a new regulation that would require fire departments, "within two years after they are made available on the market," to provide firefighters at wildland/WUI incidents with a "full-face, NIOSH-certified, Class 3, powered air purifying respirator (PAPR) that meets the requirements of NFPA 1984, Standard on Respirators for Wildland Fire-Fighting and Wildland Urban Interface Operations (2022 version)." This served as the motivating event in establishing our partnership LA County Fire and CAL FIRE. We worked together to organize two Operational Field Assessments (OFAs) of prototype wildland/WUI respirators in Castaic, on August 30, 2023, hosted by LA County Fire, and in Redding, on September 30, 2023, hosted by Cal/FIRE. At each OFA, under blazing summer skies, a group of 20 firefighters ran through a series of evolutions while wearing one of five prototype wildland/WUI respirators provided by TDA Design, 3M/Scott, MSA, Sundstrom and Ventus. The evolutions included cutting line, extending a progressive hose lay, flowing water in a pump-and-roll maneuver, operating chain saws, and other actions (Figures 2 and 3).

Photo by Mike Wilson, Cal/OSHA

Figure 2. LA County and Cal/FIRE firefighters cutting line while wearing respiratory protection (PAPR and APR) at the OFA, LA County Training Center, Castaic, CA Aug 30, 2023.

Photo by Mike Wilson, Cal/OSHA

Figure 3. Cal/FIRE firefighters wearing TDA/ Drager PAPR, MSA PAPR and Sundstrom APR. At the OFA, Redding CA Sept 12, 2023

Predictably, many of the devices suffered damage from these simulated firefighting tasks; however, survey results returned by firefighters after each evolution surprised us. In general, for most participants, wearing a respirator did not prove to be a barrier to getting the work done. Figures 4 and 5 show the summary results of the final survey question that captured the overall experience of each firefighter after each of five evolutions.

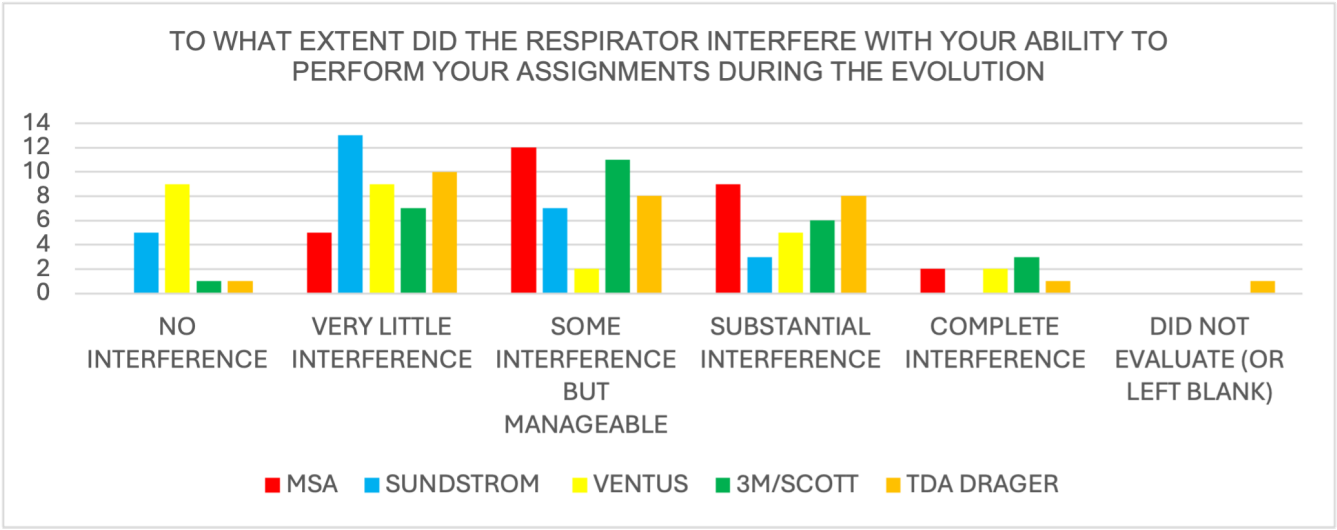

Figure 4. Summary results for the final survey question submitted by 20 firefighters after each exercise at the Castaic Operational Field Assessment, August 30, 2023.

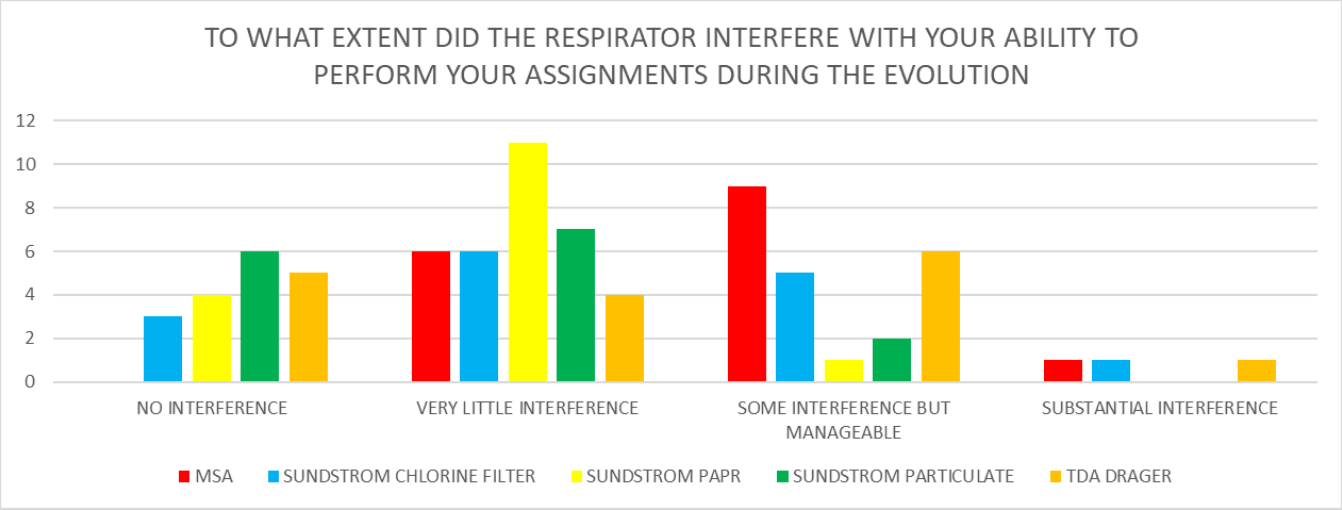

Figure 5. Summary results for the final survey question submitted by 20 firefighters after each exercise at the Redding Operational Field Assessment, September 30, 2023.

Next steps for Cal/OSHA and the fire service

Before rulemaking can begin, Cal/OSHA and the fire service will need to determine the technical criteria that a wildland/WUI respirator must meet to be permitted for use in California. These criteria will likely overlap with NFPA 1984 and the soon-to-be-developed NFPA 1985; however, those standards do not yet require a wildland/WUI respirator to be tested under smoke conditions, for example, which represents a substantial data gap. This data gap must be closed if Cal/OSHA is going to require fire departments to purchase wildland/WUI respirators and provide them to firefighters for use in the field. Similarly, we need to better understand if wearing a wildland/WUI respirator increases heat stress and cardiovascular workload. Cal/OSHA is working with investigators at UCLA and San Jose State University to address these questions.

Cal/OSHA will work with the fire service in reaching resolution on these and other technical questions, knowing that the next fire season is just around the corner. We're confident that when we finally set a timeline for the implementation of a new regulation requiring W/WUI respirators for all firefighters deployed to these incidents, the manufacturing sector will step forward with its power to innovate, and we'll begin to see new generations of respiratory protection. My expectation is that, like with the SCBA, we'll look back and wonder how we managed for so long without it.

THE WILDFIRE CONSERVANCY

CONDUCTING RESEARCH WITH FIREFIGHTERS AND AGENCIES

Dr. Derek Urwin
University of California Los Angeles, Department of Chemistry and Biochemistry, and Los Angeles County Fire Department

Given the complexity of the problems facing our firefighters today, we need a new way of solving problems. One of those solutions lies in Community Based Participatory Research (CBPR) – a collaborative approach to research where scientists and firefighters work as equal partners on all aspects of a research project. This includes:

- Developing research aims
- Study design and execution
- Intervention design
- Dissemination of findings (not just publishing papers)

Properly applied, this approach ensures that interventions are responsive to firefighter's needs and compatible with public safety duties. The success of this strategy also requires a feedback loop to evaluate the ultimate effectiveness of interventions and to apply any necessary changes and recommendations. The goal is to learn from the outcome of projects to constantly improve the process, collaboration, and results, making interventions feasible for the firefighters.

As an example, one of the hurdles to implementation of interventions is that many firefighters view preventative interventions as impractical or incompatible with public safety duties. This causes the proposed interventions to be disregarded and/or not implemented. Ensuring compliance with CBRP means we not only help improve outreach and understanding, but project partners can also help create interventions, strategies, policy, and regulations. These regulations are effective, practical, and compatible with duty, work, existing protective equipment, physiological constraints, and other factors that may not be apparent to some researchers who are unfamiliar with the rigors of firefighting.

As identified in the report by the National Academies of Sciences (2018), it is important to return individual research results to participants in the study. While this issue has been a perennial topic among the scientific community, research supporting firefighters suggests that there should be increased collaboration and transparency, especially as the research addresses critical issues related to health and safety, cancer risk, and related concerns. While the risks of returning individual research results can include concerns like unverified accuracy, firefighters deserve to be more involved in the research results, and particularly their own individual data.

Further, it is no longer acceptable to simply collect data with firefighters or departments/agencies without allowing them a more active role in the process. "Helicopter research" describes a phenomenon in which (historically) researchers from higher-income countries conducted studies in lower-income countries with minimal involvement from local researchers or community members. This practice involves the researchers "flying in" to gather data and subsequently departing without fostering significant collaboration or delivering tangible benefits to the local population.[26] Such practices raise substantial

ethical concerns due to their inherent lack of local input and the potential for exploitative research practices. Unfortunately, some of the past research on firefighters bears a stark similarity.

Research initiatives are predominantly designed and executed by researchers from outside the community, often sidelining local researchers, firefighters, and stakeholders. This lack of engagement leads to research processes that may not reflect the needs or realities of the local context or address the priorities of the agencies used for the studies. Helicopter research can perpetuate significant power imbalances between researchers and local communities, fire departments, or other participants. This dynamic can result in the extraction of data without adequately considering or addressing the needs and perspectives of the local population, further marginalizing their voices.[27]

This kind of imbalanced research also can be inherently exploitative, failing to provide meaningful benefits to the communities involved. Such practices may reinforce a cycle of dependency and disempowerment rather than contribute to sustainable development and genuine community engagement. This problematic approach to academic inquiry highlights a need for change and greater ethical considerations including the meaningful inclusion of local stakeholders in the research process.[28]

THE WILDFIRE CONSERVANCY

DAY 1:
FACILITATED DISCUSSION

During a facilitated discussion, the speakers, invited guests, subject matter experts, and attendees discussed the current state of wildland/WUI firefighting. Candor was inherently consistent with our goals. The goal was to first identify current gaps in information, and then develop a list of clear priorities for future research, projects, and support for wildland and urban interface firefighting and firefighter health and safety. The summary below describes those outcomes and recommendations.

GAPS IN INFORMATION AND PRIORITIES

1) **Cancer Risk and Interventions**
    a. Evaluating the age of onset for firefighter cancer versus the average population
    b. Improving cancer support groups and understanding how to best support firefighters, their families, and peers
    c. Evaluating the role that exercise and nutrition play as a factor in preventing and mitigating cancer – for example, evaluating the use of sulforaphane (broccoli extract) and whether it may help to increase the death of cancer cells while also reducing swelling and other effects
    d. Understanding how the sleep and duty cycle factor in cancer risk – this is especially important for wildland/WUI incidents given the long-term nature of the incidents, 24-hour work periods or longer, long deployments, poor sleep quality when off duty, and related impacts to health, immune systems, wellness, and behavioral health
    e. Supporting more holistic and interdisciplinary research and long-term longitudinal studies especially those that bring together topics like nutrition, exercise, sleep, PPE, decontamination, etc.
    f. Understanding that in some cases, we may never get to zero when it comes to exposures, and risk reduction
    g. Improving our understanding of many potential interventions (that some firefighters and departments are already using – absent suitable scientific of medical support), including sauna use and lymphatic massage/fascia release
    h. Providing targeted studies on firefighter reproductive health – paternal firefighting is associated with elevated risk of birth defects (like cleft palate, transverse limb deficiency, and total anomalous pulmonary venous return) or even cancer risk in offspring, but this is not well documented or understood
    i. Developing current cancer studies for wildland/WUI firefighters using a model like the Framingham model for research sustain-

ability and longevity; creating long-term sustainability and stability in personnel, labs, funding, priority setting, adaptive management, adaptive monitoring, dedicated resources, and long-term institutional commitment

2) **Exposures, Decontamination, Rehabilitation**
    a. Dermal Exposures
        i. Improve understanding of how to properly decontaminate the skin, or the benefits or protocols for regular and intermittent decontamination
        ii. Improve understanding of the effectiveness of different soaps, detergents, skin wipes, and related protocols and whether any of these practices or products are facilitating anything moving into the skin
        iii. Understanding what types of compounds are in the cleaning products or wipes, and whether they interact with any of the compounds or substances that we are worried about, either denaturing or enhancing them
        iv. Conducting Body Hazard Region Analysis, and assess dermal absorption, including future testing and application of flow-through diffusion methodology
    b. Improving understanding of the ototoxicity of smoke and the problems (long and short term) related to hearing, balance, infections, and other related effects from smoke exposure
    c. Respiratory exposures
        i. Developing and validating protocols for post exposure rehabilitation for carbon monoxide or other exposures; evaluating the potential use of clean air tents or other options to help rehab the lungs
        ii. Advancing understanding of the effectiveness of respirators from <u>actual</u> smoke exposure (not just against specific constituents of interest)
            1. Testing filters against only one constituent (single gas challenge) at a time. In a recent study, firefighters using APRs had greater decreases in FCV and greater increases in CC-16 and SP-A than firefighters without respiratory protection (e.g. worse outcomes) – suggesting one of two things: either some chemicals are readily breaking through filters and concentrating in the lungs more readily because of the APRs, or firefighters are moving deeper into unsafe areas because breathing is easier or they perceive their protection is greater, thereby increasing their total exposure and risk. We need to understand why this is the case, and ensure that new PPE or protocols aren't creating new or worse problems[1]

3) **Data Collection and Needs**
    a. Including cost/benefit analysis in this kind of work – workers comp claims, costs to implement mitigations, costs to retrofit, cost for new equipment, etc.
        i. Legislators/decision makers, agencies, etc. need to know

how decisions are impacting outcomes, and how they impact budgets, long- and short-term

b. Many studies focus on PAHs, PFAS, etc. We need to know more about VOCs, semi-volatiles, metals, etc.
c. Creating new policies, projects, and research that incorporate cost benefits analysis for transparency, disclosure, and greater support for decision making
d. Improving research access and response to incidents at critical times of exposure and risk
    i. We need to have the ability to respond to an incident to mobilize, collect data, get samples to labs, have human subjects protocols and Institutional Review Board approval (IRB) in place to ensure a rapid emergency deployment
    ii. We need to improve coordination and access to incidents and firefighters, ensuring no operational impacts, to improve the collection of more representative and realistic data that has not been available before
    iii. This requires filling in the gaps of information on first responders – especially those on initial attack, at the head of the fire, in the worst conditions, with the highest levels of exposures in the hardest parts of the incidents
e. Evaluating the utility of biometrics for incident command, firefighters, and personal data collection related to factors like heart rate, core temperature, hydration status, blood oxygen levels, and personal data on exposures and analysis of blood, urine, or other biological or chemical sample collections, and how this can improve:
    i. Individual decision-making and informed responses/interventions for personal protection and intervention as well as prevention and coordination with health care providers
    ii. Improved decision making at the IC for firefighter safety/health for administrative controls or other interventions for teams and/or individuals
f. Improving understanding of firefighter hydration including the kinds of drinks being consumed, with clear recommendations that can help ensure compliance and safety for firefighters, along with easier access to iced water on the fireground

4) **Retired Firefighters are an important and overlooked component of wellness and health research**
    a. Collecting long-term data including a clear baseline of health and wellness, cancer risk, and other factors at the start of a firefighter's career
    b. Providing collection of key metrics and testing immediately post career, and create long-term programs to support the tracking of retirees through various changes in lifestyle, health, wellness, and cancer risk

5) **Training and Education**
    a. Leadership is critically important to implementing lasting change – following behaviors modeled by leadership is a core part of the fire industry culture– the example they set can be either positive or

negative

b. Understanding that good and bad behaviors, protocols, myths, etc. can be passed on though leadership, most on-the-job learning happens in an informal way, passed from leadership and more experienced firefighters to newer and lower ranking firefighters
c. Providing opportunities for additional training and information on issues related to wellness, health, safety, and behavioral health to firefighters so they can make informed decisions
    i. We can't just tell firefighters about a problem, and not provide some kind of solution – while the listing of firefighting by IARC as a carcinogen was a huge and unprecedented step forward, it created an unfortunate fallout of firefighters scrambling to find solutions in a massive void of information, training, and support
    ii. We have observed that with even a small amount of knowledge, firefighters are coming up their own solutions in the absence of guidance from regulators, decision makers, and scientists (e.g. sauna use, soap types, shower regimens, etc.) with the thought that something is better than nothing
    iii. In some cases, they are basing these decisions on limited information, or at worst, misinformation, clever marketing, and pseudoscience; as practitioners in this arena, we have to do better to recognize these deficiencies and help find real solutions and protect them from potential harm
d. Translating recommendations, science, data, and information across different platforms like social media, text messaging, and other formats to reach different generations of firefighters – it has to be informative, compelling, memorable, and brief
    i. Early career firefighters need to get more information from task books or basic training related to health, safety, and wellness – including cancer awareness classes as part of the Joint Apprenticeship Committee (JAC)
e. Including social and behavioral surveys, interviews, and evaluations a regular component of health and safety research to understand the current state of understanding, and identify potential barriers to adoption, implementation, and acceptance
    i. Periodic assessments can track success and also help identify early issues with barriers and potential solutions to overcome them
f. Improving the ability for firefighters to work with their own personal doctors – a toolbox or guide to help inform their doctor that they are in a high-risk profession, that there are specific things that should be regularly looked at, and standard tests, baseline etc. that can be important for long- and short-term care

6) **Other Recommendations and Observations**
    a. Exploring the idea of technology forcing policy or regulation as a concept for PPE development, new technologies, and tools has promise
        i. Evaluating how to integrate adaptive management and adaptive monitoring into new rules that gives flexibility to meet

targets, and make progress without creating a standard that cannot be met with current technology
    ii. Creating triggers in the policies, laws, and regulations that can provide rapid feedback from agencies and the firefighters so that change can adapt and respond quickly
    iii. Allowing for more dynamic standards, and not necessarily rely on longer-term timelines of review (e.g. every five years or longer) – innovations in science and data should help drive review schedules
    iv. We also need to recognize that we are most likely never going to get to a perfect answer or a perfect solution, so we cannot allow perfection slow progress or stymie advancements
b. Including adaptive management and adaptive monitoring as part of this process to create comprehensive models to help guide future research, interventions, and policy
c. Evaluating behavioral health as an important component of overall health/wellness - this is still relevant especially regarding cancer – we need to better understand how factors like sleep, stress, anxiety, depression, etc. are related to overall wellness, and cancer risk
d. Avoiding decision paralysis: in many instances, we can't tell firefighters or agencies what to do because we don't understand the issue well enough; doing nothing should not be an option and we should not let perfection become the enemy of progress
e. Creating long-term workplace monitoring programs and air quality monitoring at stations, engines, inside the sleeping areas, basecamp etc.
    i. Developing those standard protocols with organizations and agencies like NIOSH and NIST to create national-level standards and protocols to provide consistency across departments and allow for state- and national-level assessments
    ii. Developing training programs and long-term collection stations at fire stations that firefighters could self-collect skin wipe samples, urine samples, hair samples or other key factors pre- and post-incident

THE WILDFIRE CONSERVANCY

DAY 2:
COMMUNITY RESILIENCE AND RECOVERY

In our inaugural Symposium back in 2014, an undeniable consensus emerged among participants and subject matter experts—we were witnessing a seismic shift in the landscape of wildfires. What were once isolated incidents primarily affecting vegetation began to threaten entire communities, critical infrastructure, and valued assets. Moreover, the traditional fire season was transformed; wildfires know no bounds of season, now blazing fiercely throughout the year. This led to a pivotal rebranding of our terminology. Wildfires are now recognized as "Wildland Urban Interface" fires, and what we used to call a "fire season" has evolved into the all-encompassing "Fire Year." Fast forward a decade, and these terms have become part of our everyday lexicon, reinforced by numerous and devastating incidents across California and the nation.

As we dove into Day 2 of our Symposium, the spotlight was on two equally vital strategies: Suppression and Prevention. Each plays an indispensable role in mitigating the risks of wildfires and bolstering community resilience in California. Experts emphasized the urgency for fresh, bold approaches in planning and executing land management, fuel reduction, and prevention programs—elements that are critical to California's long-term fire risk reduction strategy.

Yet, these ambitious initiatives hinge on a pressing challenge—the need for stable funding. Just like in long-term cancer studies, where ongoing support is vital to maintaining progress, the momentum gained through diligent land management can be easily lost during funding lapses. A shortage of resources and staff can quickly turn hard-fought advances back to pre-management peril. It's akin to maintaining the Golden Gate Bridge; once the painting begins, it must be continuous. A collapse of this commitment can erase years of progress toward achieving our climate and resilience goals.

The mission for Day 2 was straightforward yet ambitious: to convene state experts who can illuminate the path toward enhancing community resilience and to foster a lively discussion on how we can tackle the new realities facing California. Achieving this goal demands collaboration across a diverse spectrum—including academic and research institutions, the insurance sector, building developers, product manufacturers, and our legislators. Together, we can devise innovative strategies to confront these evolving risks head-on.

Leading the discussion from a legislative perspective, speakers from both the California Assembly and Senate joined the Symposium. Assemblyman James Gallagher (District 3) and Senator Kelly Seyarto (District 32) provided stark discussion on the current state of wildland/WUI fires in California, with both recognizing that there is considerable work to be done from a prevention and suppression standpoint. Both remained committed to improving the situation in California, recognizing the importance of science, technology, and collaboration. Their discussion helped frame the discussion on priorities and needs discussed below.

THE WILDFIRE CONSERVANCY

DISCUSSION OF WILDFIRE RISK AND RESILIENCE: A MANUFACTURER'S PERSPECTIVE

Atousa Ghoreichi
James Hardie Building Products

James Hardie, an international company with a footprint in California, was invited to participate due to their pragmatism and experience.

As we navigate the complexities of environmental challenges, it is important to consider how we can enhance our resilience outside the home, particularly in California, where year-round fire issues have become a grave concern. This portion of the Symposium explored actions we can take beyond home boundaries, the evolving role of companies in developing resilient materials, and the multifaceted challenges posed by changing regulations, laws, and our climate.

Outside the Home: Strategies and Considerations

Engaging with our communities involves proactive measures to mitigate wildfire risk and enhance overall community and individual structure resilience. The most obvious first step is to implement strategies and actions outside the home that can include:

1. Community Preparedness and Planning Programs: Organizing local initiatives that focus on fire safety education, emergency response training, and evacuation planning can empower residents and create a culture of preparedness within the community.

2. Vegetation Management: Implementing community-wide maintenance of landscaping and vegetation around homes and public spaces can reduce fuel sources for wildfires. This includes creating defensible space through the management of vegetation and the proper maintenance of trees and other landscaping.

3. Fire Breaks and Defensible Space: Communities can collaborate to establish firebreaks—strategically cleared areas that can help slow or stop the spread of fire—especially in regions prone to wildfires.

4. Water Source Accessibility: Ensuring that there are adequate water sources (e.g., ponds, hydrants, cisterns) available for firefighting efforts can bolster community resilience.

5. Collaboration with Local Governments and Homeowner Associations: Partnering with private, local, state, and federal agencies to develop policies that enforce fire safety regulations and land-use planning can enhance community resilience against wildfires.

Addressing Year-Round Fire Problems

The challenges surrounding fire risk extend beyond the immediate threat of wildfires, as California faces a range of environmental phenomena all of which can now contribute to year-round fire risk. Companies and manufacturers are increasingly establishing dedicated research and development facilities to address these complex issues including:

1. Advancements in Material Resilience: Companies are prioritizing the development of materials that are noncombustible, fire-resistant, or otherwise reduce fire risk, and can withstand other elements such as extreme heat, freezing, humidity, and flood. The aim is to create products that not only protect but also meet the realities of our ever-evolving environment.

2. Multi-Factor Consideration in Home Building: Builders are encouraged to adopt materials that respond effectively to multiple environmental challenges. In regions affected by diverse climatic conditions, such as extreme wet weather and freezing temperatures, the ability of building materials to perform consistently is crucial for resilience and insurability.

Aesthetics vs. Functionality

While ensuring the highest levels of protection is paramount, the aesthetic appeal of homes and businesses cannot be overlooked. Communities often have expectations and established design requirements that must be met. Balancing the following will be key:

1. Design and Planning Requirements: Municipal regulations or homeowners association rules may dictate certain aesthetic characteristics for structures, making it essential for modern materials to be both resilient and visually appealing.

2. Sustainable and Attractive Choices: Companies must also learn to innovate when producing materials that not only meet safety standards but also fulfill aesthetic needs, ensuring that buildings harmonize with their surroundings.

As California confronts a year-round fire problem alongside other extreme weather patterns, it is essential to implement community-oriented strategies aimed at preparedness and resilience. The collaboration between companies focusing on material advancements and local actions will be critical in facing these challenges effectively. Striking a balance between functionality and aesthetics will ultimately define the resilience of homes and communities in an ever-changing environment.

THE WILDFIRE CONSERVANCY

INSURING CALIFORNIA'S HIGH-RISK COMMUNITIES

Seren Taylor
Personal Insurance Federation of California

As a highly respected Vice President of the Personal Insurance Federation of California, Seren Taylor provided a review of California's insurance issues in high-risk wildland/WUI areas provides critical insight into the status and potential solutions to improve community resilience and safety in California.

When we think about the insurance crisis related to wildfire and Wildland Urban Interface (WUI) risk, it's natural to gravitate toward mitigation strategies as a primary solution. After all, reducing the likelihood and severity of wildfires seems like a logical approach to making properties more insurable and thus more financially secure. However, while mitigation is indeed a critical aspect of this conversation, it's essential to recognize that it is not the sole factor influencing insurance availability or the overall risk landscape.

Mitigation encompasses a range of actions aimed at reducing the impact of wildfires—such as creating defensible space around properties, utilizing fire-resistant building materials, implementing community-wide vegetation management, and engaging in proactive land-use planning. These measures are crucial for minimizing fire hazards and protecting homes and communities. Insurers consider properties that have undergone effective mitigation measures as lower-risk investments, which can lead to more favorable insurance options and premiums for homeowners. However, the insurance crisis surrounding wildfire and WUI risk involves a multifaceted interplay of different determinants beyond just mitigation. Here are several key factors that contribute to the insurance landscape:

1. The Regulatory Environment: State and local regulations directly influence insurance companies' ability to assess and price risk. Changes in building codes, zoning laws, and environmental regulations can either enhance or degrade the insurability of properties. Insurers need to navigate these regulatory landscapes, which can vary significantly from one jurisdiction to another.

2. Market Dynamics: The broader property insurance market itself plays a role in risk assessment. Economic pressures, competition among insurers, and the overall demand for coverage can affect availability. If a significant number of insurers exit high-risk markets, homeowners may find themselves with fewer options, regardless of their mitigation efforts.

3. Climate Change and Environmental Trends: Increasing frequency and intensity of wildfires is influenced by broader climate change patterns, which can overwhelm localized mitigation efforts. As scientific projections demonstrate that fires will become more common and severe in the coming years, insurers are forced to reassess risk evaluation models. This changing climate landscape creates uncertainty that can affect insurance pricing and availability.

4. Community-Level Resilience: Insurance availability often hinges on the resilience of entire communities, not just individual properties. Areas with

organized community preparedness programs, efficient emergency responses, and collaborative fire management practices are seen as less risky by insurers. The strength of community infrastructure—such as access to firefighting resources and early warning systems—also plays a crucial role in risk assessment.

5. Claims History and Loss Experience: The history of claims and loss experience in high-risk areas heavily influences insurance decisions. If a specific region has a pattern of high claims due to wildfires, insurers may respond by increasing premiums or limiting coverage options. Therefore, even properties that implement effective mitigation strategies may find it difficult to secure insurance if their local area has a troubled claims history.

6. Public Awareness and Consumer Behavior: The awareness and understanding of wildfire risks among homeowners also plays a role in the insurance conversation. Education about risk and proactive measures can drive action at the community level, leading to a culture of preparedness that insurers favor. Conversely, a lack of awareness can perpetuate risk and inhibit insurers from providing coverage.

Mitigation is undoubtedly a vital part of the solution to the insurance crisis surrounding wildfire and WUI risk; it serves as a proactive strategy to enhance property resilience and reduce risk in the eyes of insurers. However, to develop a comprehensive approach to addressing this crisis, stakeholders must also engage with other determinants of insurance availability and risk. By recognizing the roles of regulatory frameworks, market dynamics, environmental changes, community resilience, claims history, and public awareness, we can cultivate a holistic strategy that not only improves insurability but also fosters safer, more resilient communities. Only through this diverse approach and understanding can we hope to navigate the complexities of the insurance landscape and protect our homes and environments from the escalating threats posed by wildfires.

A Changing Economy of Risk

The economics of insurance was relatively stable for decades until 2017. Following the dramatic losses of 2017-2021 (mostly driven by wildfires), the cost of home construction skyrocketed. This was especially acute during 2020 which some of the largest fires occurred in California and some of the greatest increases in costs of materials were seen, due in part to supply chain challenges during COVID. This hyper-inflation associated with home construction coupled with catastrophic losses in the state has also impacted the calculus of insurance.

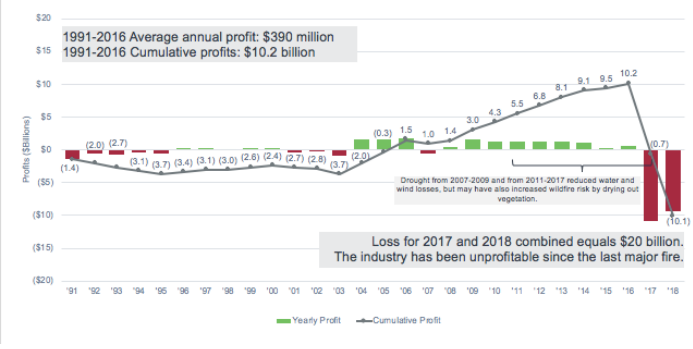

Figure 6. Source: Milliman Estimates, based on P&C Combined Industry Annual Statement data from SNL and data from the California Department of Insurance. Excludes impact of reinsurance and investment income.

According to the California Department of Insurance, over a ten-year period (2012-2021), homeowners insurance companies have done far worse in California than nationally.

- Direct profit on insurance transactions: Nationwide = 4.2%; California = -6.1%
- Direct underwriting profit: Nationwide = 3.6%; California = -13.1%
- Direct return on net worth: Nationwide = 7.0%; California = 0.8%

Confounding this, California is also ranked 24th in the nation for insurance premiums. Given the cost of homes in California and the cost of construction in the state, this is a shocking statistic.

Historically, the California Department of Insurance is slow to approve homeowners' insurance rate filings and the time to approval has been increasing. It now takes nearly one year for a rate approval. With extreme levels of inflation, especially the hyper-inflation affecting the home building and materials industry, by the time a rate is approved, it is no longer competitive.

Given all of these issues, that are not directly related to wildfires themselves, insurance companies are mitigating their risk by simply not writing new policies, or cancelling policies in the state.

Another challenge is that California uses the last 20 years of average historic losses to estimate catastrophic fire losses. This is another reason why rates are not reflecting the risks, since the years prior to 2017 were not as catastrophic in terms of loss as subsequent years. Insurers are seeking the authority to formulate rates using probabilistic models that assess a home's location, fuel risk, and condition (including mitigation features) to help set insurance premiums. California may be the only state to specifically prohibit this method (except for earthquakes). Further complicating this is the issue of reinsurance – insurance carried by insurance companies to help mitigate their own risk. This is, or course, an additional cost to insurance agencies. Again, California may be the only state in the nation that does not allow insurance companies to include the reinsurance costs to be calculated into the cost of their insurance rates passed to customers.

California FAIR Plan

The state has created a state sponsored insurance alterative, the Fair Plan, as a way to assist homeowners and property owners who could not obtain insurance through a private carrier. The FAIR Plan is a pressure relief valve for a dysfunctional insurance market. The California Fair Plan is a basic fire insurance policy designed to provide coverage for residential properties that may have difficulty obtaining insurance through conventional means, particularly in high-risk areas susceptible to wildfires. Established as a response to the increased risk of natural disasters in California, the Fair Plan is managed by the California Fair Access to Insurance Requirements (FAIR) Plan Association.

Key aspects include:

1. Eligibility: It primarily covers properties that are unable to secure standard homeowners' insurance due to factors like location, age, or condition of the home.

2. Coverage: The plan typically provides limited coverage for the dwelling itself, losses due to fire, lightning, and vandalism but may not cover personal property or liability unless additional endorsements are purchased.

3. Market Function: It is not intended to replace regular homeowners' insurance but rather serves as a last resort for property owners who are otherwise uninsured.

4. Application Process: Interested homeowners typically must apply through participating insurance agents, and the process involves providing details about the property.

Overall, the California Fair Plan aims to provide a safety net for homeowners facing challenges in acquiring property insurance.

The number of FAIR Plan policies has nearly tripled since 2017. Part of the problem is that with so many homes now insured

under the FAIR Plan, there are growing "pockets" of concentrated risk, where all applicants must be accepted into the plan, and now there are communities like Lake Arrowhead where the FAIR Plan has a total exposure of $7.7 billion. If there was a major incidents and community impact in an area like that (with most coverages held by the Fair Plan), the state would be on the hook for massive financial losses. However, if the Fair Plan is hit with a major loss, the California Department of Insurance notes that the state's insurer of last resort, the FAIR Plan, can pass costs it can't afford in the event of a major wildfire onto insurance companies (even if they don't cover those homes). Of course, those insurance companies can then try to recoup some, or all, of that money from existing policyholders. It is no surprise then that insurance companies are becoming even more resistant to conducting business in California.

How do we fix this? The science of fire mitigation is getting better at building for resilience and risk reduction and loss. Some in the insurance industry are asking to give homeowners credit for having certain hardening components on their homes, and their insurance rate should reflect these changes. However, we recognize that just because you upgrade one component on your home doesn't mean that the other weaknesses will still not allow that structure to catch on fire. So the question is whether to allow for a piece-meal approach to recognizing home hardening in the insurance industry, or whether it should be an all-or-nothing scenario. The answer may lie somewhere in between. Potential solutions discussed include:

1. **Insurance Availability in At-Risk Areas —** Requiring insurance companies to write no less than 85% of their statewide market share in distressed areas identified by Insurance Commissioner.
2. **Returning FAIR Plan Policyholders to Market —** With priority given to homes and businesses following "Safer from Wildfires" regulation.
3. **Catastrophe Models/Mitigation —** New models will recognize mitigation and hardening requirements to appropriately price rates and discount benefits; presently not available in current rate making process today.
4. **Modern FAIR Plan —** Expanding commercial coverage limits to $20 million per structure closes coverage gaps for HOAs, affordable housing, and infill developments

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DAY 2:
FACILITATED DISCUSSION

The end of the Symposium concluded with a facilitated discussion among the participants to once again identify gaps in information and priorities related to community resilience and policy making. The summary below highlights those outcomes and recommendations.

GAPS IN INFORMATION AND PRIORITIES

Participants provided the following regarding gaps and priorities.

1. Importance of Education and Community Engagement: Education is crucial for enhancing community resilience. This involves strategies like collaborating with community associations, promoting neighbor-to-neighbor connections, and implementing demonstration projects. Demonstrating clear outcomes along with a cost/benefit analyses can further strengthen understanding and participation.

2. Ensuring Community-Level Resilience: Achieving community-level resilience obliges the participation of all facets of the community. It is not clear what level of participation is needed to achieve a statistically meaningful level of community-wide protection – this isn't an area of research that has been modeled or settled yet. However, successful community protection is built on a solid foundation of individual actions.

3. Risk Mitigation at the Parcel Level: Parcel-level mitigations mainly address risks associated with vegetation burning and ember dispersal. Once a conflagration begins and homes are at risk from structure-to-structure ignitions, some home hardening measures will fall short. Therefore, a comprehensive community-level plan must be developed to effectively manage such risks.

4. Ensuring Long-term Compliance: Sustaining compliance with planning, design, and building codes presents a significant challenge for cities, counties, insurers, homeowners associations, and other stakeholders. Vegetation management requires ongoing commitment, while other upgrades, such as enhanced walls, windows, and roofs represent more permanent investments. Data collection can play a vital role in this process through:
    a. Annual assessments
    b. Development of databases for verifying mitigations
    c. Regular audits and inspections

5. Providing Options for Resilience Improvement: It is important to present individuals with a range of options for enhancing resilience, categorizing

these as good, better, and best. The cost of mitigation is a significant barrier to implementation of home hardening activities. By providing options of good, better, and best, the homeowner has agency over their property and the improvements they can make. If they cannot afford "best" they can maybe afford "good" which is always better than nothing at all.

6. Evidence-Based Mitigations: All mitigation strategies must be evidence-based to ensure their effectiveness. They need to be verified in a lab or field tested. Asking homeowners to invest in home hardening and including these measures in a certification program to promote insurance coverage is a significant investment of time, money, and trust. We need to be sure these measures are effective.

7. Supporting Local Fire Chiefs: Supporting local fire chiefs is critical for the implementation of programs and updated codes, especially regarding more controversial measures. Fire chiefs must be empowered to stand firm against community and political pressure. This is where evidence-based mitigations become critically important.

8. Incentivizing Changes through Insurance: There is a potential for offering mitigation-based insurance discounts. However, this proves complex, as various risk factors exist for each structure. For example, if a homeowner upgrades their siding but neglects their roof, determining eligibility for a discount becomes challenging. Although incentivizing change is important, quantifying the impact in terms of rate reductions or overall risk reduction remains difficult.

Improving Community Resilience: No Need to Reinvent the Wheel

The creation of programs like Energy Star or LEED certifications have set national uniform standards for improving sustainability and efficiency. For lack of a better term, a "Fire Star" Program was discussed as an initiative aimed at promoting fire resilience in building construction and retrofitting, akin to the goals of those other existing programs. By establishing standardized certifications—Bronze, Silver, Gold, and Platinum—the program can encourage homeowners, builders, and communities to adopt practices that reduce the risk of fire damage, ultimately saving lives, properties, and resources. Sample Certification Levels could include:

- Bronze: Basic compliance with fire safety standards and minimal enhancements for fire resistance.
- Silver: Improved materials and design strategies that significantly reduce fire risk.
- Gold: Advanced mitigation techniques and comprehensive community engagement to ensure widespread resilience.
- Platinum: Cutting-edge innovations in fire safety, including state-of-the-art materials, comprehensive vegetation management, and robust community infrastructure.

To encourage participation in the Fire Star Program, a range of financial incentives could be offered, including: 1) Rebates for implementing fire-resistant retrofits; 2) Tax Credits for certified homes and buildings; 3) Insurance Reductions for properties meeting Fire Star standards; or Property Tax Reductions for certified

community-wide resilience efforts. This combination of incentives should be aimed toward helping individual parcels and neighborhoods reach higher levels of resilience over time.

Recognizing the need for collaboration, the program should advocate for a shared burden of retrofits. This includes Public-Private Partnerships (PPP) involving federal, state, and local governments, insurance companies, and others to jointly contribute to the funding of fire resilience initiatives. The program could be managed by regional organizations such as SANDAG (San Diego Association of Governments) or WRCOG (Western Riverside Council of Governments) to facilitate cooperation and resource allocation across various stakeholders.

The Fire Star Program should recognize that certain areas may pose inherent risks that are challenging to mitigate, including:

- Old Designs and Materials: Structures that do not meet modern safety standards.
- Accessibility Issues: Locations where retrofitting may be difficult due to existing infrastructure or other challenges.
- Vegetation Management Challenges: Areas with dense foliage or high fuel loads that cannot be effectively managed, or those that contain sensitive resources (e.g. biological or cultural).
- Community Design and Layout Challenges: Communities that were built and designed before modern approaches to egress and access were implemented.

The program should provide guidelines for best practices and recommendations for those living in high-risk zones, emphasizing the importance of situational awareness and preparedness.

Responsibility in New Construction is another key consideration. While code is constantly being updated it doesn't always keep pace with the evolving risks of wildland/WUI fires. Further, many beneficial new technologies, designs, or materials that can measurably reduce risk could be "required" or even recommended to be used in new construction under this proposed program. This should not be a deterrent in the planning/approval process, or an impediment for developers to adopt higher standards that may benefit new homes or businesses. Developers can take a proactive lead in prioritizing noncombustible and fire-resistant designs and materials. New residents and businesses can ensure higher awareness and compliance with local fire safety regulations. Permitting authorities are ultimately responsible for approving new construction and may choose to enact building codes that align with enhanced standards, ensuring that all parties are accountable for fire resilience.

An idea like the Fire Star Program seeks to create a robust framework for fostering community-wide fire resilience, balancing safety, sustainability, and economic considerations in the face of growing wildfire and fire risks. Through education, collaboration, and innovative practices, it empowers stakeholders to collectively reimagine community risk, prioritizing higher level mitigation of fire-related hazards while enhancing property values and community safety.

PRIORITIES FOR FUTURE ACTION

1) Firefighter and Community Health/Safety: With regards to health and safety, especially for first responders, priority should be placed on selecting which products are used in construction and understanding the risk they pose when they combust. New materials are developed constantly, but little is done to evaluate the risk of exposure to firefighters and the community when it burns. This may need to be a part of materials testing under a new standard or regulations to take into account the sustainability of new materials, the combustibility of them, and the risk to firefighters and the community when they do burn. The development of new materials, which are untested exposures when combusted, can have unintended health consequences to first responders and communities. There needs to be a way to get in front of this before it becomes an issue that threatens health and lives.

   With regard to exposure risk, participants also noted the need to have rapid response teams that can deploy at major or unique incidents, to be able to collect critically important data and information that is often missed because of a lag time in a fire incident and the ability for research teams to deploy. This means having the ability to collect data and information on incidents from the perspective of smoke, contaminants, constituents of concern, and other factors during critical times, without having an operational impact or safety concerns. There was significant discussion on being able to capture data related to firefighter health/safety, attack effectiveness, and community resilience and outcomes.

2) Advancement of Code and Regulation: We need the ability to bring together codes, regulations, policies, and laws under one umbrella that evaluates it from the perspective of wildfire/WUI issues. For example, as we are solving the housing crisis in California by allowing for accessory dwelling units (ADUs) to be built in communities, these areas may be originally designed with specific assessments for vehicle traffic, maximum population, and evacuations during a major disaster, like a wildfire. The potential doubling of that population through the building and occupying of ADUs and associated increase in traffic volume may place the community at high risk for failure during an incident. This risk is likely unknown but may be substantial. Likewise, the state is encouraging the use of home battery storage in high-risk fire areas due to the prevalence of power shut offs (during events like high wind days). Other technologies are allowing electric vehicles to power homes during outages. How do these decisions impact an evacuation? Are vehicles maintaining enough reserve capacity? Are firefighters aware of the serious nature of community-wide battery storage on fire outcomes, incident complexity, and exposure risk? Unintended consequences of well-meaning ideas need to be incorporated into a more comprehensive assessment of diverse policies, laws, and regulations with a lens of wildland/WUI fires.

3) Legislative Bootcamp: an annual event that brings together key legislators, committee members, and staff for a non-partisan symposium that is led by scientific and subject matter experts for improved education and outreach. One of the challenges identified by elected officials is the need to make decisions on subjects that they may not have the most recent expertise on. A yearly "bootcamp" should foster the ability to discuss key

issues identified by legislators and staff with experts in the field and provide for both robust discussion but also opportunities to establish clear needs, goals, and priorities. The objective is to provide a commonsense approach to improving the situation for California with teams of experts willing to help. This can be a vehicle for new informed legislation and a vehicle for significant change.

4) Fellowships/Internships with the Legislators: In many cases, there is a need for subject matter experts to assist legislators and staff in the analysis of important issues or the development of significant legislation. Creating a fellowship program that places firefighters, academics, researchers, students, and subject matter experts in strategic offices and committees can serve to advance collaboration, understanding, and problem solving in California.

5) Wildland Urban Interface (WUI) Day: WUI Day could be an annual preparedness event designed to enhance awareness and readiness for wildland and wildland urban interface fire risk. Similar in concept to the "Great Shakeout," WUI Day could engage communities across the state in comprehensive educational initiatives and proactive strategies to mitigate the impact of wildfires on people, property, and the environment. The primary objective of WUI Day is to establish a continuous and coordinated outreach program that equips firefighters, municipalities, state, federal, and tribal agencies, as well as community members, stakeholders, and businesses with essential knowledge and tools related to wildfire prevention and crisis management. Core activities could include:

    a. Educational Workshops: A series of hands-on workshops focused on fire safety, prevention measures, and response in the event of a wildfire. These sessions could cater to completely different audiences including first responders, homeowners, businesses, and municipal officials.
    b. Drills and Simulations: In collaboration with local fire departments and agencies, WUI Day could feature practical drills simulating emergency responses to wildfires, providing participants with experiential learning opportunities to better prepare for real-life incidents.
    c. Information Dissemination: Informational materials, toolkits, and resources designed for various stakeholders will be disseminated to enhance understanding of fire behavior, risk assessment, evacuation planning, and mitigation techniques.
    d. Community Engagement: Interactive programs such as community fairs, online webinars, and neighborhood outreach initiatives could foster discussion and build a culture of preparedness within communities at risk.
    e. Agency and Stakeholder Collaboration: The event could serve as a platform for collaboration among federal, state, and tribal agencies, and other vital parties ensuring unified strategies and sharing of best practices for wildfire management and emergency response.

WUI Day not only addresses the urgency of wildfire preparedness but fosters a resilient mindset among communities. By creating an annual tradition of education, collaboration, and engagement, WUI Day will cultivate a proactive culture around wildfire awareness that extends beyond a single day—ensuring that communities remain informed and prepared to face the challenges posed by wildland and WUI fires for years to come.

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