Recommended Actions Related to Reducing the Known Risk of Cancer in Fire Fighters

INTRODUCTION

Cancer is the second leading cause of line-of-duty deaths among fire fighters today, following cardiovascular disease, as established by numerous scientific studies and data collected and evaluated by the National Institute for Occupational Safety and Health and by the International Association of Fire Fighter's (IAFF) Line of Duty Deaths Database (http://www.iaff.org/hs/lodd/advancedSearch.asp). These databases demonstrate that occupational exposure to carcinogens significantly increases fire fighters' risk of several cancers in correlation with the duration of firefighting activities. Cancer deaths among members of the fire service have risen dramatically over the last 20 years, in tandem with the increasing toxicity of modern fires, due to the proliferation of synthetic products and plastics containing halogenated fire retardants, perfluorinated compounds (used to make materials stain resistant), phthalates, plasticizers, and other toxic chemicals that release carcinogenic by-products when burned.

The National Response Team (NRT) Emergency Responder Health Monitoring and Surveillance (ERHMS) Technical Assistance Document (http://erhms.nrt.org) recommends pre-deployment medical screening, during deployment health and exposure monitoring and surveillance, and post-deployment health monitoring and surveillance that supports both the prevention of and early recognition of cancers in fire fighters.

The NRT ERHMS document (http://erhms.nrt.org) recommends implementing and maintaining an Exposure Reporting/Medical Database. The ERHMS program at the National Institute for Occupational Safety and Health (NIOSH) is developing software that will meet this need and will be freely available when released in fall 2016.

Although modern medicine has led to improvements in the diagnosis and treatment of cancer, primary prevention remains the best way to reduce cancer cases and mortality. Primary prevention involves identifying cancer-causing agents and avoiding exposure to them. Over the past 40 years, researchers have identified many agents that cause cancer in humans. The Occupational Safety and Health Administration (OSHA), NIOSH, the International Agency for Research on Cancer (IARC), and other agencies have published guidelines for protecting workers and the general population from known carcinogens.

In light of these facts, a holistic approach to cancer prevention is urgently needed for the fire service and the government entities that employ fire fighters. To that end, this white paper calls for fundamental changes in most aspects of firefighting, including the design and use of personal protective equipment (PPE) to address inhalation and interface issues, which allow for upper/lower torso and head/face exposures, and operational issues, such as post-fire decontamination of personnel, equipment, fire apparatus, and fire stations. In addition, education

and medical oversight with regard to occupational cancer should be strongly emphasized throughout every fire fighter's career. Addressing all of these issues will have a substantially greater impact than addressing them individually on the incidence and mortality of firefighting-related occupational cancers and escalating cancer-related medical and personnel costs.

BACKGROUND

Epidemiological studies demonstrate a high risk of numerous site-specific cancers among fire fighters including cancers of the brain, digestive tract, genitourinary tract, lymphohematopoietic and respiratory systems (Daniels et al., 2014). Two recent NIOSH studies provide the strongest evidence linking firefighting and cancer risks to date (Daniels et al., 2014; Daniels et al., 2015).

Overall, the epidemiological data show that fire fighters are at increased risk for multiple cancers, and his/her cancer risk increases significantly with the duration of firefighting. A meta-analysis of 32 studies of fire fighters reported increased risks for the cancers mentioned in the NIOSH study as well as multiple myeloma (LeMasters et al., 2006). This review also asserts it is highly unlikely that fire fighters would get only one type of cancer, because he/she is exposed to multiple chemicals via multiple exposure routes. Since then, several studies of fire fighters in various locations have been published:

- Florida (Ma et al., 2006)
- California (Bates, 2007; Tsai et al., 2015)
- Korea (Ahn et al., 2012)
- Three U.S. cities (Daniels et al., 2014; Daniels et al., 2015)
- The Nordic countries (Pukkala et al., 2014)
- Australia (Glass et al., 2014)
- Scotland (Ide, 2014), and France (Amadeo et al., 2015)

These studies have added to the evidence for fire fighters' elevated risk of various diseases:

- Melanoma (Bates, 2007; Pukkala et al., 2014; Glass et al., 2014; Ide, 2014; Tsai et al., 2015)
- Mesothelioma (Daniels et al., 2014; Pukkala et al., 2014; Glass et al., 2014)
- Myeloma (Tsai et al., 2015)
- Leukemia (Tsai et al., 2015)
- Brain cancers (Tsai et al., 2015)
- Esophageal cancer (Daniels et al. 2014; Tsai et al., 2015)
- Colorectal cancer (Ahn et al., 2012; Daniels et al., 2014; Amadeo et al., 2015)
- Kidney cancer (Daniels et al. 2013; Ide, 2014; Tsai et al., 2015)
- Bladder cancer (Ma et al., 2006; Ahn et al, 2012; Daniels et al.,2014; Glass et al., 2014)
- Prostate cancer (Bates, 2007; Daniels et al., 2014; Pukkala et al., 2014; Glass et al, 2014; Tsai et al., 2015)
- Testicular cancer (Ma et al., 2006; Bates, 2007; Glass et al, 2014; Ide, 2014)

Recommended Actions Related to Reducing the Known Risk of Cancer in Fire Fighters

The NIOSH Firefighter Study–Phase I (2013) examined cancer incidence and mortality in approximately 30,000 career fire fighters from the Chicago, Philadelphia, and San Francisco fire departments over a 60-year period (1950 to 2009) and compared the fire fighters' cancer risk to that of the general population (Daniels et al., 2014). The study found increased risk among fire fighters for solid cancers, including digestive, genitourinary (kidney, bladder, prostate), oral, and respiratory cancers, as well as mesothelioma. The NIOSH Firefighter Study–Phase II (2015) estimated exposure potentials in the same cohort as defined by the number of fire calls, number of exposed days, and/or number of fire run-hours (Daniels et al., 2015). One of the key findings was that lung cancer and leukemia mortality risks increased with fire fighter exposures. The Nordic Firefighter Study (2014) examined more than 16,000 male fire fighters from five Nordic countries and reported that fire fighters were at an excess risk for prostate cancer and melanoma between the ages of 30–49 and an excess risk for mesothelioma at ages 70+ (Pukkala et al., 2014). These data indicate that the same conclusions are being found in different observational studies. The Australian Firefighter Study (2014) was the first study to look at career, part-time and volunteer fire fighters (Glass et al., 2014). The key findings included a "site-specific increased risk" of prostate cancer, melanoma, and male breast cancer for fire fighters with more than 20 years on the job, and brain cancer in part-time female fire fighters.

Biomonitoring studies have shown that, even when wearing full PPE with respirators self-contained breathing apparatus, fire fighters accumulate high levels of carcinogens in his/her bodies compared with average levels in the general population. The carcinogens include polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers used as flame retardants, perfluoroalkyl compounds used in non-stick coatings and firefighting foams, and combustion by-products (Fent et al., 2014, 2015; Pleil et al. 2014; Shaw et al., 2013; Park et al., 2015; Dobraca et al., 2015). A recent study found that DecaBDE (BDE-209), a neurotoxic flame retardant released by burning treated plastics, was the predominant flame retardant in serum after fire response and may be an important "signature" compound for firefighting exposure (Shaw et al., 2013). The same study found carcinogenic brominated dioxins and furans at levels 100 times higher than general population levels in the blood of individual fire fighters (Shaw et al., 2013). Extremely high levels of BDE-209 have been detected in fire station dust, suggesting that back-tracked dust from the fire scene is a substantial ongoing source of exposure (Shen et al., 2015).

Overall, these data indicate that occupational exposure places fire fighters at increased risk for cancer. However, causality between specific exposures and fire fighter cancers needs to be further demonstrated. Efforts are underway to elucidate a causal relationship between chemical exposures and biologic markers of early cancer development among fire fighters.

RECOMMENDATIONS

Fire departments across the country vary in the level of funding and resources available to them for personal protective equipment and, by extension, cancer prevention. To reduce cancer incidence and mortality among fire fighters, fire departments must implement cancer prevention approaches through the use of personal protective clothing and equipment, education and

training, and improved operating procedures and wellness/fitness programs. The following recommendations not only place emphasis on the development of new programs and equipment, but also place a greater obligation on the employer and the end user to take protective measures in these toxic environments.

1. Increase Fire Service Awareness of Cancer Health & Wellness

A holistic approach to fire fighter health and wellness of fire fighters should include behavior on- and off-duty. Mandatory programs that include medical exams, physical fitness evaluations and programs, tobacco use and tobacco cessation, behavioral health and proper nutrition are lifestyle issues as well as employment issues. Health and wellness must include proper techniques for using PPE and respiratory equipment and decontaminating equipment and apparatus at the scene of fire incidents. Cancer screening protocols must be included as part of the annual physical evaluation. Just as fire departments are required to have respiratory protection plans, health and wellness plans should also be required.

The International Association of Fire Fighters (IAFF) and International Association of Fire Chiefs (IAFC) created the Fire Service Joint Labor/Management Wellness-Fitness Initiative (WFI) in 1996 to improve the health and fitness of fire fighters and paramedics across North America. Medical, wellness and fitness programs that are developed and implemented in accordance with the WFI will help secure the highest possible level of health to fire response personnel. These programs have also been shown to provide the additional benefit of being cost effective (IAFF, 1997/2000/2008), typically by reducing the number of work-related injuries and lost workdays due to injury or illness. Annual medical examinations and cancer screening provide early diagnosis before the fire fighter becomes symptomatic and increases the likelihood of successful treatment.

Fire departments must offer annual medical examinations, fitness evaluations and individual fitness program design, rehabilitation following injuries and illnesses, and behavioral health services. The medical program must specify protocols for physical examinations, laboratory testing, and other objective tests (pulmonary function testing, electrocardiograms, audiometry, chest x-rays) as well as scheduled cancer screens. Fitness evaluation must assess aerobic capacity, strength, endurance, and flexibility using the specified protocols.

The medical component provides a cost-effective investment in early detection, disease prevention, and health promotion for fire fighters. It provides for the initial creation of a baseline from which to monitor future effects of exposure to specific biological, physical, or chemical agents. Baseline and subsequent annual evaluations will make it possible to detect changes in an individual's health that may be related to his/her work environment and allow physicians to provide fire fighters with information on occupational hazards and his/her current health status. Clearly, it allows the jurisdiction to limit out-of-service time through preventive early intervention of potential health problems.

Recommended Actions Related to Reducing the Known Risk of Cancer in Fire Fighters

NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*, which the IAB has adopted, includes a stringent standard for candidate fire fighters, as well as more flexible guidance for medical determinations for incumbent fire fighters based upon the specific nature of his/her condition and the duties and functions of his/her job. This standard was developed for and primarily intended as guidance for physicians, to provide them with advice on the relationship between an individual fire fighter's essential job functions and his/her medical condition(s). The standard categorizes medical conditions, organized by organ system, according to their ***potential*** to interfere with a member's ability to safely perform job essential tasks. Most importantly, for incumbent fire fighters diagnosed with one or more of the conditions listed, the standard ***does not indicate a blanket prohibition*** from continuing to perform the essential job tasks, nor does it require automatic retirement or separation from the fire department. The standard gives fire department physicians guidance for determining a member's ability to medically and physically function using the individual medical assessment.

The federal government, through NIOSH, also recognizes that hiring and maintaining medically and physically fit fire fighters is an important step in reducing fire fighter occupational diseases. They now fully support the Wellness-Fitness Initiative (WFI) and NFPA 1582 and further recommends that jurisdictions adopt this program and standard.

A critical part of Health and Wellness programs are lifestyle issues, specifically nutrition and tobacco use. Fire departments must develop programs that incorporate nutrition goals for fire fighters that encourage healthy eating behaviors, both at work and at home, and maintaining a healthy weight. Nutritional programs must address alcohol consumption and, where needed, assistance through Employee/Employer Assistance Programs.

Tobacco continues to be a leading cause of disease, including cancer. Many state and local governments have established polices forbidding on- and off-duty use of tobacco for new hires and establishment of tobacco cessation programs for incumbents that use tobacco. Tobacco cessation programs must include education, counseling, and drug therapy where applicable. The IAB supports these policies and further agrees that tobacco use must be forbidden in all fire department facilities and vehicles.

The National Network of Tobacco Cessation Quitlines is a state/federal partnership that provides tobacco users in every state with access to the tools and resources they need to quit smoking; ensuring the highest level of assistance to tobacco users who want to quit. The toll-free number 1-800 QUIT NOW (1-800-784-8669) serves as a single point of access to all state-based programs. The federal government website, Smokefree.gov, is maintained by the Tobacco Control Research Branch of the National Cancer Institute and provides choices that best fit the needs of tobacco users.

2. Investigate Issues Affecting PPE Effectiveness in Reducing Exposure to Carcinogens
Over the past several decades, fire fighter PPE has undergone significant evolution, such that it now provides greater protection in most circumstances against a wide range of fireground and

other incident hazards. In addition to advances in the thermal and physical protection PPE provides, material and design technology has also been applied to create lighter, more flexible, and more breathable gear for improved mobility and heat stress reduction. The emergence of sensor-based technologies have also afforded new opportunities to enhance PPE effectiveness. However, each item in a PPE ensemble is still treated as a separate element; PPE ensembles are not developed as a total system to uniformly protect the fire fighter. There are no specific requirements to address how well interface areas keep out hazardous substances, including carcinogens. It has been established that particulate matter representative of fire smoke can readily make its way through points at which PPE items are joined (IAFF, 2015), particularly in the head/neck region, which is typically covered by a porous knit hood without a form of a barrier material (IAFF, 2015). Similarly, soot particles that readily absorb fire gases and other substances easily make their way into the clothing system through the glove-coat sleeve, footwear-pant leg, coat-pant, and coat front closure interfaces. Recently, the marketplace has introduced new protective hoods incorporating a barrier material to restrict fire fighter exposures, but standardized methods do not exist for qualifying these products or full ensembles for their ability to prevent or limit fire fighter skin exposures to carcinogens.

Fire departments are responsible for integrating PPE into a system, but have no guidance on how to minimize hazardous exposures. The large number of clothing material and design choices in the industry makes it difficult for fire departments to make informed decisions. In addition, PPE may not be adequately cleaned to remove residual fireground contamination that can lead to chronic exposures to carcinogens from repeated wearing. The effectiveness of cleaning procedures to fully remove different forms of contamination has not been assessed. Moreover, some types of PPE may be not frequently cleaned or may not be designed so that they can be easily cleaned or decontaminated. Overall, requirements and procedures are lacking for validating claims of PPE effectiveness against exposure to carcinogens. It is the position of the IAB that, to induce industry to develop improved PPE that addresses carcinogen exposure and removal, PPE standards need to be updated, validation procedures need to be developed, and guidance should be provided to aid departments in selecting PPE that minimizes carcinogen exposure.

3. Implement and Maintain an Exposure Reporting/Medical Database

The fire service lacks a universal system for reporting fire fighter exposures during incident responses. Current exposure reporting practices are generally non-existent or at a local level only. Exposure reporting is necessary to create a causal link between responses and occupational injury or disease. Data must follow a fire fighter from the time he/she joins the fire service, through his/her career, and throughout his/her retirement. The IAB supports other agencies such as the IAFF, IAFC, the National Institute of Standards and Technology, and the Commission on Fire Accreditation International in encouraging the development of the National Fire Operations Reporting System (NFORS) that will collect and store retrievable data, recording events that may have exposed fire fighters to cancer-causing toxins and other health risks.

4. Improved Cancer Education

Education and training on fire fighter cancer must begin during recruitment and continue throughout every fire fighter's career. These programs must cover the effects of carcinogen exposure and cancer prevention, including wellness and fitness programs, data collection, and PPE use. Education and training should emphasize the protective limitations of PPE in preventing many fireground exposure. The programs should include Department Standard Operating Procedures relating to the proper use and cleaning of PPE. Education should cover fire fighter-specific cancer exposure risks and how to minimize those risks. The fire fighter cancer risk reduction curriculum should be standardized so it can be institutionalized nationally. The IAB supports the development and delivery of comprehensive training and education programs addressing fire fighter cancer.

5. Reduce Fire Fighter Exposure to Cancer at Fire Service Facilities

Air quality in fire houses should be constantly monitored. Diesel emissions produced during multiple cold starts followed by reentry of the apparatus into the firehouse over time exposes fire fighters to carcinogens. Although most apparatus includes exhaust treatment devices, they do not capture all toxic gaseous matter. Similarly, firehouses equipped with different types of ventilation systems or means of source capture for diesel exhaust may or may not be effective. Since exhaust filter mechanisms in vehicles do not eliminate carcinogenic exposures and limit non-carcinogenic exposures, such as carbon monoxide and oxides of nitrogen, these mechanisms must be used in concert with a local exhaust system such as tail pipe exhaust capture systems. General ventilation should only be used as an interim solution, because general ventilation only dilutes the ambient air and does not eliminate exposure. Older firehouses will need additional ventilation equipment; new firehouses will need to incorporate ventilation engineering at construction that provides for a clean atmosphere at all times. Living quarters should maintain a positive pressure environment to minimize the ingress of contamination from the apparatus bay into areas where fire fighters work, eat, and sleep. Contaminated PPE and equipment should further be isolated from living and working areas where practical. PPE should not be stored in apparatus areas. Fire station air quality standards should be established and compliance mandated. The IAB supports the constant monitoring of air quality in fire department facilities and the proper selection, installation, and use of vehicle exhaust capture controls.

6. Introduce Post-Fire Cancer Prevention Procedures

Post-fire procedures that reduce the exposure of fire fighters to products of combustion and other toxins are extremely important to overall exposure reduction. Recommended procedures involve turnout gear removal, isolation and cleaning of PPE; equipment cleaning and decontamination; medical monitoring; and rehydration. After the fire, fire fighters should immediately remove soot from head and neck areas using wipes and other field decontamination techniques. At the firehouse, showers should be taken after every fire to wash away dangerous particulates that have penetrated PPE interface areas. Protective clothing should be washed in machines specifically designated for this type of use in accordance with procedures meeting the manufacturer's specifications. Procedures should be part of the aforementioned mandatory health

and wellness plan. The IAB supports research programs that address post-fire exposure reduction procedures and the development of standard criteria measuring their relative effectiveness.

7. Create More Coordinated Standards and Criteria Promoting Fire Fighter Cancer Prevention

Regulations, standards, and requirements should be established for all the issues mentioned in this document. Specific requirements related to fire fighter health and wellness, PPE performance, PPE cleaning and care, station design and air monitoring, apparatus performance and decontamination, fireground incident rehabilitation, fire fighter education and training should be addressed in existing and new standards. A specific overarching committee should be created by the NFPA that is devoted to coordinating a holistic approach among the various standards for comprehensively addressing the fire fighter cancer issue. It is the position of the IAB that the NFPA Standards Council should form a new project specific to creating a responsible intercommittee coordinating group regarding standards on fire fighter occupational exposures related to cancer.

8. Support Fire Fighter Cancer and Worker Compensation Benefits

In recognition of the causal relationship of the firefighting occupation and cancer, almost all states have now enacted some type of presumptive disease law to afford protection to fire fighters with these conditions. Similar legislation has been proposed, but not passed, in the U.S. Congress to provide similar protection for federal fire fighters. All of these laws presume, in the case of fire fighters, that cancer is occupationally related. Consequently, their provisions rightfully place the burden of proof on the fire fighter's employer when denying workers' compensation claims and/or retirements benefits.

Further precedent for such benefits has been established through the James Zadroga 9/11 Health and Compensation Act of 2010 and its reauthorizations, which list occupational cancers that are to be covered by the World Trade Center Health Program. Currently, the list includes 60 types of cancers as approved conditions based on exposure based methodology. As with the World Trade Center program, cancer benefits for fire fighters should include those cancers:

(1) where there is *limited* or *sufficient* evidence in humans as established by the International Agency for Research on Cancer;
(2) arising in regions of the respiratory and digestive tracts; and
(3) where epidemiologic studies have found some evidence of increased risk in fire fighter populations.

In a study of fire fighter occupational disease issues relative to workers' compensation and presumption of diseases associated with firefighting, the authors stated that these "presumptions" are based on the evidence as required by adjudication, not on scientific certainty, and reflect a legitimate and necessary interpretation of data for the purpose of worker compensation for an injury (in this case, an exposure that led to a disease) (Guidotti, 2007). The authors made it clear that the assessments are for medicolegal and adjudicatory purposes and are not intended to

replace the standards of scientific certainty that are the foundation of etiologic investigation for the causation of disease. There are social constructs required to resolve disputes in the absence of scientific certainty and the foundation for legislation or revised worker compensation regulations that provide a rebuttable presumption when a fire fighter develops an occupational disease. Based on actual experience in those states, the cost per claim is substantially less than the unsubstantiated figures asserted by others. The reason for this, unlike benefits for other occupations, is the higher mortality rate and significantly shorter life expectancy associated with firefighting and emergency response occupations. These individuals are dying too quickly from occupational diseases, unfortunately producing a significant savings in workers' compensation costs and pension annuities for states, provinces, and municipalities. Accordingly, the IAB supports the enactment, maintenance and improvement of such benefits on the federal and state level.

Please contact the InterAgency Board at info@interagencyboard.us with any comments, feedback, and questions. Additional information on the InterAgency Board is available at www.interagencyboard.org.

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Recommended Actions Related to Reducing the Known Risk of Cancer in Fire Fighters

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