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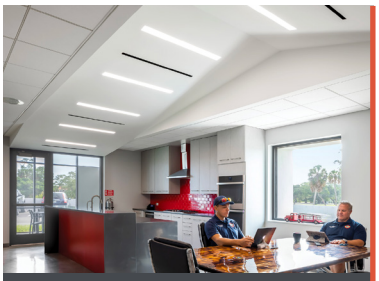

The bottom line: Firefighters have higher rates of certain cancers than the general population, they get cancer at a higher rate, and they get it earlier in life.

FIRE STATION DESIGN FOR CANCER PREVENTION

By Todd Sweet, AIA, LEED AP; Karl Bernhard, AIA; Cole Mears, Associate AIA; and Chase Meyers, Associate AIA Sweet Sparkman Architecture and Interiors

INTRODUCTION

Firefighters across the nation face life-threatening scenarios every day. Yet, the most insidious threat to their health and safety is one they cannot combat with a hose and ladder—cancer.[i]

Since the 1990s, public health researchers have sought answers when it became apparent that high numbers of firefighters were dying from cancer—often young, previously healthy, and with no family history of the disease.[ii] In 2010, a multi-year U.S. government study[iii] was launched to investigate this alarming trend. Now, reports indicate that 66 percent of career firefighter line-of-duty deaths from 2002 to 2019 can be attributed to cancer.[iv]

Along the way, 48 states have passed laws establishing a presumption that certain types of cancer contracted by firefighters were the result of duty-related exposure, with North Carolina and Delaware being the exceptions. This legislation has opened the door for affected firefighters and their families to receive restitution through enhanced retirement and pension benefits, workers' compensation, and death and disability benefits.[v] Such actions, unfortunately, only address the consequences of the cancers, not the cause.

With mounting research on line-of-duty health risks, the goal is now focused on awareness and prevention.

While no single preventative panacea yet exists, cancer prevention strategies should remain a core focus for all stakeholders in order to protect firefighters, mitigate related financial burdens on governing authorities, and create safe and healthy spaces for emergency services personnel.

The question, of course, is how.

According to the Firefighter Cancer Support Network (FCSN), a significant portion of the answer can be found in building, asserting that architects "should be working to design the cancer out of fire stations."[vi]

We agree and readily accept the challenge.

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CANCER AND FIREFIGHTING BY THE NUMBERS

Career firefighters have a 9% higher risk of being diagnosed with cancer and a 14% higher risk of dying from cancer than the general U.S. population, according to joint research by the Centers for Disease Control and Prevention (CDC) and the National Institute for Occupational Health and Safety (NIOSH).

When specific types of cancer are factored out, these risks are even more significant for firefighters than the general population. For instance: [vii]

- **Testicular cancer – 2.02 times greater risk**
- **Multiple myeloma -1.53 times greater risk**
- **Skin cancer – 1.39 times greater risk**
- **Brain cancer -1.31 times greater risk**
- **Colon cancer -1.21 times greater risk**
- **Mesothelioma – 2.0 times greater risk**
- **Non-Hodgkin's lymphoma – 1.51 times greater risk**
- **Malignant melanoma – 1.31 times greater risk**
- **Prostate cancer – 1.28 times greater risk**
- **Leukemia – 1.14 times greater risk**

There is also evidence that instances of breast cancer are higher in female firefighters than in the general population. [viii]

MITIGATING ENVIRONMENTAL RISKS

There are many sources and compounding issues that contribute to higher cancer rates among firefighters, which ultimately requires a multi-pronged and layered solution.

Post-Event Decontamination and Containment

Today's fire scenes are highly toxic environments, resulting from the increased use of synthetics in modern structures, furnishings, electronics, and flame retardants (purposely designed to smolder before catching fire). Unfortunately, many of these synthetics create more smoke and release airborne carcinogens that are inhaled or absorbed through the skin despite protective gear. This absorption is exacerbated by heat, and with every five degrees in body temperature rise, skin absorption rates increase by as much as 400%.[ix]

After fire events, firefighters return to their stations after having been exposed to atmospheric aerosol particles, dust, and other carcinogenic particulates such as asbestos. These residual products of combustion are carried into the station on their bodies, personal gear, and various pieces of equipment, which in turn contaminates their living areas.

In addition to the chemical exposure from the fire events, firefighters are also exposed to carcinogens present in some of their personal protective equipment (PPE) and diesel exhaust from their fire engines. Chemicals such as per- and polyfluoroalkyl substances (PSAs) present in firefighters' PPE and in firefighting foam are referred to as "forever chemicals" because they don't break down easily in the environment. These chemicals have been linked to a variety of cancers and are known to interfere with immune function, endocrine function, and breast development.[x]

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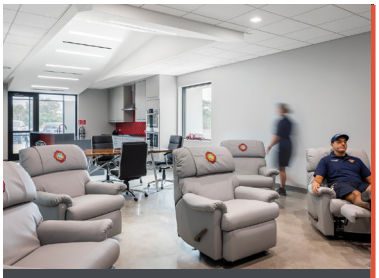

Many jurisdictions are finding themselves tasked with renovation or new construction of their fire facilities to meet the demands of population growth, code requirements and the changing nature of fire services, like an increase in female firefighters, demanding new uses of those buildings.[xi] These new and/or renovated structures will not only have to address cancer issues but incorporate risk-reduction strategies for events, such as the recent pandemic.

There is a human element, as well, that must be addressed through proper education and protocols, according to the National Fire Prevention Association (NFPA). From weary firefighters choosing sleep over showers to those who consider not using self-contained breathing apparatuses or wearing soiled PPE as badges of toughness and bravery,[xii] it is essential that design teams try to understand the mindset of the men and women who use the space. We endeavor to create designs that encourage them to make the healthy choice by making that choice easier and more attractive.

A significant architectural design solution for these potential dangers is mindful space planning and creation of decontamination zones to prevent the spread of potential carcinogens into living quarters. A relatively new concept, this "zoning" is aimed at managing three levels of exposure to contaminants—a Hot (or Red) Zone for high hazard, a Transition (or Yellow) Zone for moderate hazard, and a Cold (or Green) Zone for low hazard. This strategy has been deemed "life-changing" by the station design conference director at Firehouse, Endeavor.[xiii]

Also necessary are storage rooms for contaminated PPE and equipment. These rooms must be appropriately located and ventilated. Contaminated articles should have dedicated, high-quality washer-extractors and gear-drying equipment separate from the living areas where first responders reside between emergencies.

DIESEL EXHAUST

Diesel exhaust, generated whenever the fire engine leaves or returns to the station, can spread throughout the apparatus bay and living quarters. If not adequately captured or ventilated, the NFPA notes, it can result in extended periods of exposure for firefighters during their shifts.[xiv] These harmful emissions are confirmed carcinogens by the Occupational Safety and Health Administration (OSHA).[xv] Since the exhaust is heavier than air, it also settles on the gear firefighters keep folded down next to the truck for quick access when there's an emergency call. This practice, studies have indicated, has resulted in a high rate of testicular cancer among firefighters.

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Mitigating this threat requires state-of-the-art equipment and systems for proper ventilation, adequate airflow, and removal/capture of the carcinogens and particulates. In doing this, Sweet Sparkman's team has found it critical to work closely with a specialty engineering firm to coordinate vents with mechanical, electrical, plumbing, etc. Isolation of bunker gear storage with direct exhaust to exteriors is another crucial component, as are doors that automatically close with an air pressure system that helps push out toxins. Incorporation of such negative-pressure and filtration systems guard against contaminants remaining in designated areas, drawing clean air into a room and exhausting contaminated air.

As noted above, clear separation of living quarters from the apparatus floor and separation of the building into hot, warm, and cold areas is also key. These are sometimes identified as red/yellow isolation zones, which create physical separations and minimize contamination of firefighter living areas.

SYSTEM DESIGN FOR HEALTHIER OVERALL ENVIRONMENTS

Unfortunately, cancer is not the only health threat faced by firefighters, who are routinely exposed to physical hazards such as heat, noise, and, for those taking on emergency medical response duties, the risk of exposure to infectious agents. As a result, they are also at increased risk of cardiovascular and pulmonary disease as well as noise-induced hearing loss.[xvi] Additionally, according to the International Association of Fire Fighters (IAFF), exposure to very high levels of mold that can be found in older stations can cause hypersensitivity pneumonitis, which has symptoms similar to pneumonia.

While not all of these dangers can be addressed through design, some can, such as mold mitigation.

In addition, the inclusion of a fitness room in fire and emergency services facilities is now standard practice, according to the Federal Emergency Management Agency (FEMA). This practice is an acknowledgment not only of the difficult physical challenges faced by responders but also the fact that many injuries and illnesses can be eliminated or minimized if individuals are physically fit. For instance, the agency reports that many sudden cardiac and stroke deaths occur in responders who are not physically fit. Thus, it is considered essential that these workers have access to strength, cardio, and flexibility training.[xvii]

EDUCATION AND PROTOCOL DEVELOPMENT

The design of fire stations, though critical, is not enough to protect these first responders. That's why it's vital that post-design education takes place that instructs first responders on proper protocols for creating a safe space, using guidance from organizations such as the IAFF.[xviii] To foster this, we work closely with fire departments to lay out the station congruent with their desired decontamination protocols and procedures. We also share the knowledge we've gained through years of designing state-of-the-art fire department facilities while updating others to conform to modern safety practices. In addition, we encourage regular inspection and maintenance of systems installed to create a safe environment.

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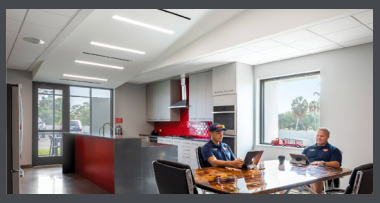
DESIGNING CANCER OUT

Our deep research and experience in the integration of cancer-prevention elements in the design of new or renovated stations has led us to a robust menu of options to protect firefighters and emergency medical personnel from the effects of carcinogenic and related hazards. And while the above physical elements are necessities, their exact placement and integration are critical to their effectiveness.

MOVING FORWARD

While it seems to have taken some time for the issue of cancer in firefighters to gain traction, legislators in states such as Florida, for instance, are actively seeking solutions at a faster pace, as evidenced by a recent proposal to mandate direct vehicle exhaust systems in fire stations. Additionally, the attention brought to first responders of all types due to the pandemic has seeped outside industry publications and into the popular press, which will hopefully continue to elevate this cause in the public eye. This newfound awareness, combined with a push made by older firefighters who want to protect their younger counterparts with the hard-won knowledge gained in their careers, will continue to spur change in the industry from both the preventative and reactionary ends toward a healthier paradigm.



A HOUSE OF A DIFFERENT COLOR

The design of fire stations is a skill unto itself, as they are critical facilities that house personnel, serve (and possibly host) the public, and represent the community. The following are some of their unique needs and factors that we keep in mind when designing or redesigning such a structure:

- **Operational efficiency**
- **Day-to-day operations**
- **Sustainability/low maintenance**
- **Acoustics**
- **Vehicular circulation/parking, shift change**
- **Security/access control**
- **Disaster response**
- **Hurricane hardening**
- **Designing for zones: hot, cold and transition zones**
- **Cost control/budget maximization**
- **Outside activities and public image**
- **Future space needs**
- **Communications and technology integration**
- **Training and fitness**
- **Building new in a floodplain or below FEMA**
- **Emergency back-up**
- **Feeling like "home"**

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PUTTING IT ALL TOGETHER

It is clear: more must be done to assure that fire stations are a safe haven for the first responders that utilize them. Despite some measures being instituted nationwide, actual validation of their results will take time, given their recency. That said, it is equally obvious that in every ounce of prevention there remains a pound of cure.

Today, there are growing reports on the impact of informed design *reducing* cancer among firefighters. Informed design includes changes in the habits of first responders, the implementation of gear cleaning protocols, and the installation of various systems to address contamination. However, until these measures are more frequently employed holistically in the *prevention* of cancer, firefighters will continue to be affected.

New measures include implementing wearable toxin-exposure technology, aggressive cancer screening for firefighters, and a greater emphasis on general health with a focus on addressing modifiable lifestyle factors associated with cancer. As outlined by the Mayo Clinic,[xix] such factors include avoiding tobacco use, eating a healthy diet, maintaining a healthy weight, remaining physically active, using sunscreen, and having all appropriate vaccinations for viral infections that increase the risk of certain cancers.

Firefighter organizations also believe that to adequately address the health issues of first responders, their primary care providers must better understand the physiological demands of firefighting and be aware of research concerning the health risks to which firefighters are most prone. To that end, the International Fire Chiefs Association has created a guide to assist healthcare providers in evaluating, treating, and monitoring firefighters' unique health and wellness needs.[xx] Its medical recommendations are research-supported and experience-driven. It was written by physicians, healthcare professionals, researchers and fire service experts experienced in evaluating and treating firefighters. The concise format and research-based content have been well received by physicians looking for information on the health needs of firefighters.

In another effort aimed at getting ahead of the problem, the IAFF encourages on-scene gross decontamination. In its guide,[xxi] "Reduce Your Exposure to Carcinogens," the organization outlines the steps required to safely decontaminate firefighting ensembles on-site, cleanse exposed skin, and safely store contaminated materials for transport back to the fire station.

There is also a general agreement among public health researchers that more research and tracking are needed to understand the problem entirely. As a result, federal legislation has been enacted requiring the Centers for Disease Control (CDC) to set up a National Firefighter Registry to track links between their workplace exposures and cancer. The National Institute for Occupational Safety and Health (NIOSH) will take the lead in establishing the registry.

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CONCLUSION

As fire stations nationwide continue to age out and be replaced or upgraded, the prevention of cancer should be top of mind. For the elected and appointed officials charged with these replacement and upgrade projects, it is important to choose the right people who are committed to the elimination of factors contributing to cancer in firefighters.

And that's where architecture—and architects experienced and skilled in public safety design—can affect positive change. Knowledgeable design professionals can work with firefighter leadership to address all aspects of firefighter safety and assure optimal, long-term station performance.

To that end, the Firefighter Cancer Support Network (FCSN) is clear in its recommendation. "Responsible elected and appointed officials should require this type of expertise when hiring design professionals for fire stations."

Only then will our protectors be truly protected.

ABOUT SWEET SPARKMAN ARCHITECTURE & INTERIORS

Sweet Sparkman Architecture and Interiors, located in Sarasota, Florida, is a multi-disciplinary architecture and planning firm specializing in community-oriented projects and high-end residential, as well as interior design. Since its beginnings as Sweet Sparkman Architects in 2004, the award-winning firm has designed and permitted more than 20 fire facilities. For more information, visit sweetsparkman.com.

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