

## Hierarchy of contamination control in the fire service: Review of exposure control options to reduce cancer risk.

### SUMMARY

The international fire service community is actively engaged in a wide range of activities focused on development, testing, and implementation of effective approaches to reduce exposure to contaminants and the related cancer risk. However, these activities are often viewed independent of each other and in the absence of the larger overall effort of occupational health risk mitigation. This narrative review synthesizes the current research on fire service contamination control in the context of the National Institute for Occupational Safety and Health (NIOSH) Hierarchy of Controls, a framework that supports decision making around implementing feasible and effective control solutions in occupational settings.

### FINDINGS

- Evidence-based measures that have been investigated and that can be implemented to protect firefighters during an emergency response, in the fire apparatus, and at the fire station were identified.
- While a great deal of research and development has been focused on improving personal protective equipment for the various risks faced by the fire service, these measures are considered less effective.
- Less research and development have been focused on higher level control measures such as engineering, substitution, and elimination, which may be the most effective at cancer prevention, but are challenging to implement.

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(2022).  
Journal of  
occupational and  
environmental  
hygiene, 19(9),  
538–557.

<https://doi.org/10.1080/15459624.2022.2100406>



## TAKEAWAYS

- Much of the research has focused on improving PPE for the various hazards faced by the fire service. However, as contamination control concerns are incorporated into PPE design, the impacts on thermal protection, wearability and heat stress must also be considered.
- Several studies have evaluated administrative and engineering controls that can be used during the firefight, as well as during recovery from the emergency incident. However, more research is needed on the most effective and efficient means to work on the fireground and clean equipment, apparatus and individuals after emergency and training fires.
- Notably less research has been conducted on quantifying the benefits for controls, such as substitution and elimination. Implementing these controls may require compelling scientific evidence, local policy shifts, and potentially larger political action.
- While biological monitoring has provided support for some types of control measures, many of the control options described in this review are based on air or surface sampling or even professional judgement. Additional studies are needed to quantify the impact of specific control options on biological uptake of hazardous substances and to document the mechanistic link between exposure and health outcomes.

## FIRE STATION TALKS

- Firefighters are exposed to a wide range of carcinogens as a result of responding to emergencies.
- There are three primary routes of entry for toxic compounds to enter the body: inhalation, ingestion, and dermal absorption.
- Research has spent a lot of time examining how to prevent or decrease the risk of cancer among firefighters.
- There is a range of control options that provide various levels of effectiveness in preventing exposure to carcinogens.
- Least effective, but most commonly studied are PPE related controls. Wear your SCBA during all phases of fire ground operations, and make sure you have properly fitting bunker gear. Always use your particle blocking hood.
- More effective controls are administratively related. These include various fire attack tactics and effective crew rotation.
- Also, ensure PPE decontamination at the fire ground and retire out of date or torn PPE.
- Clean the inside of the cab of the fire apparatus after exposure.
- Engage in regular, deep station cleaning especially of the bays and areas where PPE and tools are kept.
- Engineering controls which may be more effective than administrative controls include fire station design, diesel exhaust capture, and training prop design.
- Substitution controls may be more effective, however, are less understood empirically. These include training fuel selection, replacing hazardous chemicals in products with less hazardous chemicals (fluorine-free foam), replacing diesel apparatus with electric or hybrid-electric apparatus.
- The most effective form of control would be elimination, which is big picture focused and includes the increased installation and use of smoke alarms and sprinklers and massive fuel reduction efforts in the wildland-urban interface.



## CHIEF PERSPECTIVE

- Ensure all firefighters have properly fitting gear and hoods. Instill a culture of safety where SCBAs are worn during all phases of fire ground operation, especially during overhaul.
- Ensure all firefighters properly wash bunker gear and hoods after exposures. Make this accessible by having extractors and dryers at as many stations as possible and provide firefighters with a second set of gear.
- Consider using transitional attacks on the fire ground as firefighters are less exposed to carcinogens after hitting it hard from the yard first.
- Routinely rotate interior crews. This decreases heat stress injuries and ensures proper time for PPE decontamination.
- Participate in on-scene decontamination.
- Integrate proper donning and doffing of PPE. Particular focus should be placed on doffing hoods and gloves to decrease cross contamination.
- Stock all fire apparatus with cleansing wipes and encourage firefighters to utilize them post fire prior to returning to the station.
- Clean the interior and exterior of fire apparatus after exposure.
- Rigorously and routinely clean the fire station, specifically the apparatus bay and turnout gear lockers.
- Don't allow PPE to be stored or transported in personal vehicles unless stored in an airtight container.
- When designing new fire stations, consider designs more conducive to firefighter health utilizing the red, yellow, and green zones. Do not place common rooms, offices, or bunkrooms near the apparatus bay.
- Ensure apparatus bays have a proper diesel exhaust capturing system with ventilation.
- Wisely consider the type of fuel used in live fire training events to reduce exposures unnecessarily.
- Replace AFFF with fluorine free foam.
- Consider PPE without fluorinated compounds.
- As technology continues to develop, consider replacing aging diesel apparatus with electric or hybrid-electric vehicles.

