



Protection from Environmental Dangers During Fire Restoration

Introduction

According to The National Fire Protection Association (NFPA), every 24 seconds a fire department in the United States responds to a fire somewhere in the nation. Although the number of fires and direct fire deaths has decreased significantly since the 1970's, the NFPA and multiple government agencies are increasingly focused on the long-term risk to the health of those individuals that respond to fires. While a majority of the research related to risk from fire contaminants is focused on the firefighters, the implications for restoration contractors are substantial.

This reference article is designed to summarize current information related to health risks for restoration contractors from exposure to soot and fire residue. In addition, it offers recommendations for work practices and protective steps to mitigate both short-term safety and long-term health risks for individuals involved in the restoration of fire damaged structures.

Characterization Of Fire Residue

While every structure that has been impacted by fire has the common trait of something burning, each incident is unique in regards to the type and amount of gases, vapors, smoke, soot, and particulate material that was produced by the fire. For the purposes of this reference article those materials will be identified as fire residue. Figure 1 is an example of the situation encountered by restoration professionals following a residential fire. The number of burned materials contributing to the fire residue is so extensive that it is difficult to fully characterize such a work space from an environmental health perspective.

The specific mix of fire residue released during a fire is dependent on a myriad of factors including the type of fuel, temperature of the fire, oxygen availability, and firefighting methods. The NFPA published a paper in 2015 entitled *The Environmental Impact of Fires*. This document identified a number of hazardous materials that are often present in the soot and residue from fires including heavy metals, small particulates, chlorinated dioxins and furans, brominated dioxins and furans, polychlorinated biphenyls (PCBs), poly fluorinated compounds, and polycyclic aromatic hydrocarbons (PAHs).

Known Health Concerns

With the abundance of chemical compounds produced by combustion and the variability of potential contaminants; it is no wonder that questions have been raised regarding the potential health effects of exposure to fire residue. Researchers have known since the 1700's that exposure to soot and other fire residue can cause cancer.

Numerous recent studies conducted for firefighters have shown that hazardous compounds in soot and fire residue clings to uniforms, respirators, tools, and skin allowing for the significant potential for cross-contamination. This transference of hazardous contaminants is greatest when fire residue is being disturbed during investigations or moved during cleanup activities.

A secondary concern is the development of microbial contamination in fire damaged structures due to the humid environments that are created by the fire suppression water and the buildings being partially open to the elements, even with tarps in place. Figure 2 shows mold growth that developed in a fire restoration project due to delays in getting agreement on the scope of work.



Figure 1



Figure 2

Fire Restoration Is Not The Same As General Cleaning

Given the consensus from numerous credible organizations including the Center for Disease Control and Prevention (CDC), the Department of Health and Human Services (HHS), the National Cancer Institute (NCI), the National Fire Protection Association (NFPA), the International Agency for Research on Cancer (IARC), and others that exposure to fire residue can cause both short-term and long-term problems, reasonable steps need to be taken by restoration contractors to prevent exposure to their workers and nearby occupants.

Not only are prudent protective actions such as the setup of isolation barriers to minimize the spread of fire residue, the use of air scrubbers to lower particulate levels, and the use of personal protective equipment (PPE) to minimize skin and respiratory exposure part of the current industry standard of care; they are required under the *general duty clause* of the Occupational Safety And Health Act (OSHA). That section of the OSHA regulations mandates that employers protect their workers from any known

hazards, regardless of whether or not those hazards have risen to the level where specific permissible exposure limits have been established. Figure 3 shows a restoration professional setting up HEPA filtered equipment in order to create negative pressure inside the work zone while ensuring that contaminants are not exhausted directly to the out-of-doors.

Since proper fire restoration activities generally require medical evaluations in order to use respiratory equipment, specialized training, fit testing, the use of professional engineering controls, and equipment designed to control the spread of odors and small particulates, such work could not be approached as "general cleaning".

The use of personal protective equipment by individuals who could be exposed to fire residue during the initial phases of the restoration also confirms that fire restoration activities cannot be taken lightly. Indeed, the U.S. General Services Administration (GSA) definition of hazardous materials is any item or chemical which is a "health hazard" or "physical hazard" means that potential exposure to fire residue by restoration professionals is classified as hazmat work. Figure 4 is an example of the type of fire residue that typically has to be cleaned after the general removal of burnt/damaged materials are completed. Typically, this cleaning must be completed in a fashion that puts an individual no farther than arms-length from the contaminants; which necessitates the use of personal protective equipment.



Figure 3



Figure 4

Recommendations For Protecting Restoration Workers

Researchers from the National Institute for Occupational Safety and Health (NIOSH) recommend disposable clothing be used by individuals who will encounter soot and fire residue because of the potential for the presence of PCBs in the fire restoration environment. The frequent presence of PCBs in fire residue makes the proper cleaning of reusable protective gear, such as mechanic-style coveralls or lab coats, problematic at best. Therefore, NIOSH recommends the use of disposable, single use, zip up coveralls with integrated hood and boots along with elastic at the wrists to minimize exposure. They specifically suggest Tyvek or other types of fabrics which prevents the pass-through of small particles.

The NIOSH recommendation for the use of disposable suits needs to be matched with other protective equipment in order to minimize the possibility of exposure to fire residue during cleaning and restoration activities. Since typical contaminant exposure levels are heavily influenced by the specific work activities, the recommendations for minimum PPE requirements during fire restoration activities are provided based on two levels of activity that may impact the fire residue.

For brief inspections of fire damaged areas, non-invasive cleaning of the areas adjacent to those with visible fire residue or discernible smoke odors, and final cleaning after visible fire residue has been removed (see figure 5 as example of recommended PPE):

- properly fitted N100 filtering face piece
- eye protection
- non-penetrable disposable suits with attached hoods and boots (Tyvek or equivalent)
- surgical-style gloves made from nitrile or other similar material (not latex)



Figure 5

For invasive activities such as removal and cleanup of areas with visible fire residue or discernible smoke odor (see figures 6 and 7 as examples of recommended PPE):

- hard hat
- washable safety shoes or boots, such as those utilized for category three water restoration work
- properly fitted N100 filtering face piece and eye protection, or properly fitted full-face negative pressure respirator with HEPA cartridges
- non-penetrable disposable suits with attached hoods (Tyvek or equivalent)
- surgical-style gloves made from nitrile or other similar material (not latex), or disposable mechanic-style gloves with finger and palm protection to prevent transference of the fire residue through the glove.



Figure 6



Figure 7

In addition to the use of personal protective equipment, provision should be made for proper hygiene of the workers at break and the end of the work shift. Appropriate equipment and supplies should be set up at the worksite so that hand and face washing/wiping can be conducted by each worker at the site as part of PPE doffing process. Depending on the situation, this requirement can be met with the provision of an appropriate supply of disposable personal wipes.

Cross-contamination to fire restoration workers can also occur from equipment and vehicles. Therefore, it is strongly recommended that provisions be made for cleaning tools and equipment before it leaves the site. While disposable wipes can work for this purpose if it is a small project, the use of a pump-up foamer with an appropriate fire residue cleaning chemical and disposable cloths is a much more effective way of preventing cross-contamination. That same type of cleaning process can be used for decontamination of the passenger spaces of vehicles that are driven to fire restoration project.

More Information

The information presented in this reference article comes from a large number of sources including the following:

- *Understanding the Hazards of Fire Residue Encountered During the Restoration Process*, Michael Pinto and David Batts – The IICRC's Journal of Cleaning
- *Soot, as Found in Occupational Exposure of Chimney Sweeps* – International Agency for Research on Cancer
- *Report on Carcinogens, Fourteenth Edition*, National Toxicology Program – Department of Health and Human Services
- Soot – National Cancer Institute
- *Soot Pollution 101*, Jackie Weidman and Susannah Marshall – Center for American Progress

- *The Danger of Soot and Debris in Fire Damaged Buildings*, Chip Merlin – Merlin Law Group
- *The Toxicological Mechanisms of Environmental Soot (Black Carbon) and Carbon Black: Focus on Oxidative Stress and Inflammatory Pathways*, Rituraj Niranjana and Ashwani Kumar Thakur – *Frontiers in Immunology*
- *The Hidden Hazards of Fire Soot*, Dawn Bolstad-Johnson – American Institute for Conservation of Historic and Artistic Works
- *Worker Safety During Fire Cleanup* – Centers for Disease Control and Prevention
- *Toxic Exposure in Structure Fire Settings*, Sean Scott – Actionable Insights, April 2018
- *Contamination of firefighter personal protective equipment and skin and the effectiveness of decontamination procedures*, Kenneth Fent, et.al – *Journal of Occupational and Environmental Hygiene*, 2017
- *Airborne contaminants during controlled residential fires*, Kenneth Fent, et.al – *Journal of Occupational and Environmental Hygiene*, 2018
- *Recommendations for Developing and Implementing a Fire Services Contamination Control Campaign*, Jeff Stull, Peg Paul, Julie Reynolds, Marni Schmid, and Robert Tutterow – Research Foundation for the NFPA Mission

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The Restoration Industry Association (RIA) is the only international, professional trade association for the cleaning and restoration industry. Its national and international member firms specialize in cleaning, treating and repairing damaged buildings and their contents. RIA sponsors education, training, and certification programs. For more information, visit www.restorationindustry.org.

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