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Respirator Usage by Wildland Firefighters

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Tech Tip Highlights

- Based on a 7-year comprehensive study by the National Wildfire Coordinating Group (NWCG), a 1997 consensus conference concluded that routine use of air purifying respirators (APRs) should not be required.
- APRs provide protection against some, but not all harmful components of wood smoke, and may expose firefighters to higher levels of unfiltered contaminants, such as carbon monoxide. In addition, APRs do not protect firefighters against superheated gases and do not supply oxygen.
- Firefighters may use APRs on a voluntary basis if certain conditions are met.

Introduction

All firefighters, fire management officers, and safety personnel should understand the issues related to using air purifying respirators (APRs) in the wildland firefighting environment. This Tech Tip is intended to provide information regarding the regulatory requirements for using APRs, how APRs function, and the benefits and risks associated with their use.

Respirator Types and Approvals

Respirators are tested and approved by the National Institute for Occupational Safety and Health (NIOSH) in accordance with 42 CFR Part 84 (Approval of Respiratory Protection Devices). Respirators fall into two broad classifications: APRs that filter ambient air, and atmosphere-supplying respirators that supply clean air from another source, such as self-contained breathing apparatus (SCBA).

APRs include dust masks, mouthpiece respirators (used for escape only), half- and full-facepiece respirators, gas masks, and powered APRs. They use filters or cartridges that remove harmful contaminants when air is passed through the air-purifying element. Filters trap particulate matter, and cartridges have a sorbent (usually activated carbon) that absorb gases and vapors; combination filter/cartridges do both. Dust masks usually only contain material to filter particulates, however, some include sorbent material to reduce nuisance levels of gases and vapors.

NIOSH respirator selection criteria (found at <http://www.cdc.gov/niosh/docs/2005-100/chapter3.html>) does not differentiate between structural and wildland firefighting. According to NIOSH, the only acceptable form of respiratory protection for firefighting is a full-facepiece, pressure-demand SCBA. However, SCBA are impractical for most wildland firefighting applications due to their weight (approximately 20 to 35 pounds), bulk, and limited service life (30 to 60 minutes). Note: SCBA should be considered when there is a risk of inhaling products from structural combustion.



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There are no current NIOSH or National Fire Protection Association (NFPA) respirator standards for wildland firefighting. The NFPA technical committee contemplated wildland respirator requirements during the creation of the 1993 edition of NFPA 1977: *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*. However, the respirator requirements were removed from the draft standard because the health hazards of smoke in the wildland setting could not be quantified at the time and because a respirator protecting a firefighter from all health hazards of smoke did not exist.

Health Hazards of Smoke Study

The National Wildfire Coordinating Group (NWCG) coordinates wildland firefighting among Federal and State agencies, and is comprised of representatives from the Forest Service, U.S. Department of Agriculture; four U.S. Department of the Interior agencies (Bureau of Land Management, National Park Service, Bureau of Indian Affairs, and U.S. Fish and Wildlife Service); the Intertribal Timber Council; the National Association of State Foresters; the U.S. Fire Administration; and the Federal Emergency Management Agency.

Between 1989 and 1997, the NWCG studied the health hazards of smoke at wildland (initial attack and project fires) as well as prescribed fires in the Western United States. The comprehensive study included smoke characterization, employee exposure, health effects, risk analysis, and an evaluation of respiratory devices. Firefighters were fitted with systems to collect breathing zone samples, and data were collected on the three primary hazards of wildfire smoke: respirable particulate matter, aldehydes (formaldehyde and acrolein), and carbon monoxide (CO) (Sharkey 1997). The study indicated that less than 5 percent of firefighters were exposed to concentrations that exceeded limits established by the Occupational Safety and Health Administration (OSHA) (Reinhardt and others 2000a; Reinhardt and others 2000b).

A consensus conference was then held in 1997 to review the results of the NWCG study and provide recommendations. Participants included scientists and researchers, fire management officers from a wide range of Federal and State agencies, and personnel from regulatory agencies such as OSHA and NIOSH. The participants ultimately concluded that toxic emissions were present in smoke, but the incidence of exposures in excess of OSHA exposure limits was relatively low, and the documented health effects were moderate and often reversible. As such, they recommended that respiratory protection *not* be required and instead recommended changes to tactics and strategies to further minimize firefighter exposures (Sharkey 1997).

Respirator Pros and Cons

Benefits of using a respirator for wildland firefighting include filtration of respirable particulate matter and, depending on the type of filter or cartridge used, a reduction of other hazards of smoke. But any benefit to using a protective device must be balanced against potential risks. Although APRs can reduce respiratory irritants associated with wildland fire, they are a partial solution at best. Other than SCBA, there are currently no NIOSH-approved respirators that address all the health hazards of smoke. Further, APRs do not protect against superheated gases or CO, and they do not supply oxygen.

Another problem with using APRs is the potential for decreased awareness of smoke concentrations. Specifically, some components of smoke, such as acrolein and formaldehyde, are highly irritating to the mucous membranes, providing a “warning” that smoke concentrations are high. When using respirators, firefighters may stay in dense smoke longer because the irritation has been reduced, therefore leading to longer exposures and higher concentrations of unfiltered smoke components, such as CO. Using an APR during mopup can be hazardous as well, as CO is produced most abundantly during the smoldering (incomplete combustion) phase of a fire.

Respirators also impose a physical burden. When the Forest Service’s Missoula Technology and Development Center (MTDC) studied respirators, it found that they decrease firefighter work capacity because of breathing resistance, heat stress, and respirator weight. APRs can also cause a sense of breathlessness during strenuous effort and may cause claustrophobia (Rothwell and others 1995). In addition, beards and facial stubble reduce the effectiveness of an APR because they disrupt the seal between the respirator and the face. Lastly, and perhaps most importantly, respirator usage may also change firefighter behavior. Firefighters who assume they are better protected may take unnecessary risks or increase their risk tolerance.

Regulatory Requirements

The need for respiratory protection must be determined by each employer; equally, employees cannot use a respirator or similar protective device without the employer's approval. If an employer determines that respiratory protection is not required, air purifying respirators can be used voluntarily if certain conditions are met.

There are three conditions of respirator use: 1) voluntary use of a dust mask, 2) voluntary use of respirators *other than dust masks* (such as half- or full-facepiece APRs), and 3) respirators that are required to be worn in the workplace. OSHA's 29 CFR Part 1910.134 outlines the different requirements for the three conditions of use and are explained as follows:

Voluntary use of a dust mask: The employer must 1) determine that using the respirator will not interfere with the employee's ability to work safely, 2) ensure that dust masks are not dirty or contaminated, and 3) provide a copy of Appendix D of 29 CFR Part 1910.134 ("Information for Employees Using Respirators When Not Required Under Standard") to each voluntary wearer (Department of Labor 1998).

Voluntary use of respirators *other than dust masks*: The employer must develop and implement a written respirator program that ensures that the use of the respirator itself will not create a hazard.

When respirators are required to be used in the workplace: The employer must develop and implement a complete written respirator program that includes the following provisions as applicable:

- Procedures for selecting respirators for use in the workplace.
- Medical evaluations of employees required to use respirators.
- Fit testing procedures for tight-fitting respirators.
- Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations.
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators.
- Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere supplying respirators.
- Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations.
- Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance.
- Procedures for regularly evaluating the effectiveness of the program.

A NIOSH-approved respirator is not required if use is voluntary; however, OSHA strongly recommends using a respirator that is NIOSH-approved. If you are considering a non-NIOSH-approved device for voluntary use, the product should be evaluated carefully for suitability for the intended application, including, fit, filtration, and/or absorption performance (if any), breathing resistance, and heat and flame resistance.

Appropriate APR for Wildland Firefighting

Based on the low incidence of exposures in excess of OSHA-allowable limits found during the NWCG study, the following NIOSH-approved respirators could be considered:

- Dust mask: N95 respirator, preferably with sorbent material to reduce nuisance gases and vapors; or
- Half- or full-facepiece respirator with combination organic vapor/acid gas cartridge and N95 filter.

Note: An N95 filter is 95-percent efficient in filtering 0.3 µm (micron) particles.

Full-facepiece APRs can be considered if eye protection is a concern, and some can be fitted with a spectacle kit for prescription eyeglasses. If you choose a full-facepiece respirator, a nose cup (oro-nasal cup) is recommended to reduce fogging and carbon dioxide buildup in the facepiece.

Again, keep in mind that APRs are only a partial solution for wildland firefighting because they do not address all of the health hazards of smoke. In addition, NIOSH-approved respirators have not been evaluated for heat and flame resistance of the filter material or respirator itself. No matter what, evaluate all of the tradeoffs associated with using an APR during wildland firefighting operations.

Do Bandanas Provide Protection?

Bandanas have been used by wildland firefighters for decades, however, they should not be considered a viable choice for respiratory protection. Scanning electron microscope photographs of both new and used bandanas have shown openings (pore sizes) within the fabric that exceed 100 µm in length and width, which allow particulate matter to pass freely through the fabric (Reh and others 1994).

Conclusion

The NFPA is once again considering the development of a respiratory protection standard for wildland firefighting. If such a standard is created, it must address all routine respiratory hazards associated with wildland firefighting, including CO, and the respirator must be NIOSH-approved.

Firefighters, fire management officers, and safety personnel should carefully consider all of the tradeoffs related to using respiratory protection devices for wildland firefighting, including weighing benefits against potential risks. If respirators are worn, reasonable care should be taken against fighting fire more aggressively or remaining in dense smoke for longer periods of time.

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