

Prototype Mask Protects Firefighters

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The need to provide the **wildlands** firefighter with adequate respiratory protection has received a great deal of attention this fire season. "**Smoke**" is a complicated and variable mixture of **particulates**, liquid droplets, and gases. Medical evaluation of wildlands firefighters' exposure during the past several fire seasons has indicated what most of us already know: Breathing smoke is not good for one's health.

The minimization of smoke exposure to firefighters at the Lawrence Livermore National Laboratory (LLNL) is a rule of basic operations. Five years ago, Fire Chief John Sharry implemented a policy that requires LLNL firefighters to wear full-face air-purifying respirators to minimize smoke exposure when responding to wildlands fires and during controlled burns.

To improve the performance of this piece of equipment, the LLNL Hazards Control Department has initiated a small research and development project to incorporate an electrochemical sensor for carbon monoxide into the mask. Dr. Joseph Stetter of Transducer Research Inc. is also working under contract to LLNL on this project.

The use of air-purifying respiratory protection in the fire service is nothing new. Before self-contained breathing apparatus was mandated by law for structural firefighting, the Universal canister full-face respirator (UCFR) was widely used. This air-purifying respirator used a canister that contained a filter, various adsorbents for vapor removal, and catalytic material to remove low concentrations of carbon monoxide.

For a number of reasons, inadequate protection by this device in structural fire environments resulted in several major disabilities or death. These incidents culminated in the banning of the UCFR for

structural firefighting. One overwhelming concern has resulted from these incidents, however: the potential misuse of air-purifying respirators (APRs) used by the fire service.

Therefore, any department considering the implementation of industrial full-face APRs for wildlands firefighters must also implement strict control procedures as well as a training program that details how the equipment should be used and its limitations.

The equipment, depending on the choice of air-purifying cartridges, is designed to remove particulate material and low concentrations of some organic vapors and acid gases. These respirators do not provide oxygen, and therefore must never be used where oxygen deficiency is possible.

The user can choose from two types of air-purifying cartridges. The first is an **organic-vapor/acid-gas (OV/AG)** cartridge with a **prefilter** that consists of adsorbents that remove some volatile acid gases and organic vapors and a prefilter for particulate removal. The other is the high-efficiency particulate air (HEPA) filter, which removes 99.97 percent of particulates 0.3 μm or larger in size.

At present, there is no requirement to eliminate either of these two cartridge choices. Of the two, however, the OV/AG cartridges with prefilters are less quantifiable for smoke removal. The HEPA filter cartridge, on the other hand, provides a quantifiable number for the basis of respirator selection. Either selection requires the user to understand the limitations of the air-purifying elements.

At LLNL, we have used the OV/AG cartridges and prefilters with no complaints of odor or eye irritation from the firefighters. Laboratory research studies are planned for this winter to determine the

actual percent of smoke penetration through the OV/AG **prefilter** configuration and the HEPA filter configuration.

Therefore, anyone currently using this equipment should consider the choice of the air-purifying cartridges carefully. What works for LLNL may not be correct for different applications. At present, the HEPA filter choice is the most dependable because the filter element has an established efficiency (99.97%) for small particulates. The wearer must understand that the HEPA cartridge will not remove vapors or gases.

The need to improve and standardize wildlands firefighter equipment has been recognized by the fire service for some time. The NFPA's (National Fire Protection Association) Committee on Fire Service Protective Clothing and Equipment has recently formed a subcommittee on Wildlands Firefighting Protective Clothing. Respiratory protection will be addressed in this new standard as well as other protective equipment.

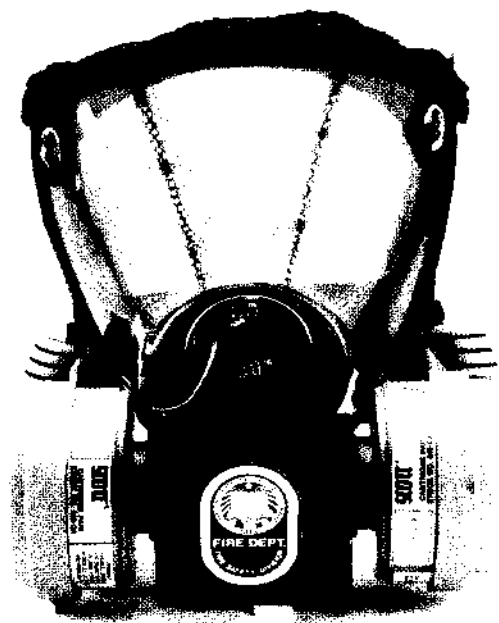
In summary, respiratory protection is an issue that is either being studied or being ignored by most

organizations. Because there is no complete answer to respiratory protection, most organizations are doing nothing, and firefighter exposures continue.

The current LLNL choice of a full-face APR is an interim corrective action. Our experience to date indicates that this respirator significantly reduces smoke exposure. It also provides eye protection, and post-response respiratory irritation is eliminated.

We also understand that gases such as carbon monoxide and other vapors can penetrate this respirator, but worse is the alternate choice of doing nothing. These limitations are provided to the responding firefighters so they do not misuse the equipment. It is also LLNL policy that this equipment is only to be used for wildlands firefighting.

In addition, we have recognized the need to better understand and quantify the efficiency of the currently available air-purifying elements for smoke removal, as well as address carbon monoxide penetration. Research is underway to better characterize the air-purifying elements and develop a real-time carbon monoxide monitor that will be incorporated in the mask.



Concern over the short- and long-term effects of smoke on wildlands firefighters spurred scientists at the Lawrence Livermore National Laboratory to include an electrochemical carbon monoxide sensor (shown at left) in a filtration mask. The combined unit is shown at right. Photo courtesy Lawrence Livermore National Laboratory.