The Following information is based on material prepared by the American Lung Association

RESPIRATORY PROTECTION FROM INHALATION HAZARDS

The inhalation of harmful dusts, toxic gases and vapors at fire and explosion scenes is a primary hazard to investigators who typically arrive after fire suppression operations are completed. In these situations, adequate respiratory protection is critical to avoid exposure and potential short and long-term adverse health effects. Fire scenes often contain harmful byproducts of combustion such as acroelin; aldehydes; benzene; toluene; ethyl benzene; xylene; formaldehyde; hydrochloric acid; polynuclear aromatic hydrocarbons; respirable dust; hydrogen cyanide; carbon monoxide, nitrogen dioxide, sulfur dioxide; and asbestos. Some of these substances have been classified as known or potential human carcinogens.

Some fire and law enforcement agencies with no formal respiratory protection programs assume that low cost, disposable dust-type masks are suitable for investigators to use while processing fire scenes. As was determined during the investigation into the collapse of the World Trade Center, these types of masks offered little or no protection against the majority of harmful substances in the air in and around the scene. As a result, many firefighters involved in the initial response to the incident continue to suffer from a variety of chronic respiratory problems.

Some agencies choose this type of mask because the use of such devices is not subject to the requirements of OSHA's *Respiratory Protection Standard* (29 CFR 1910.134). However, dust-filtering masks provide no protection against toxic gas or suffocation from oxygen-deficient environments. Investigators with potential for intense exposures often need respirators designed for such special situations. A respirator equipped with a 3-way combination cartridge (organic vapor, particulate and acid gas) or a positive-pressure self-contained breathing apparatus (SCBA) provides a much higher level of protection from toxic or noxious fumes and gasses from burning materials. Dust masks also often fail to maintain a tight face-to-facepiece seal that allows harmful contaminants to enter the airway and lungs. In addition, these types of masks offer no protection from eye exposures.

The following information was prepared by the American Lung Association and provides a good summary of the issues involved in environmental hazards with respect to respiratory protection and limiting the potential for lung injuries due to inhalation of environmental hazards.

WHAT ARE RESPIRATORY HAZARDS?

A respiratory or breathing hazard exists when a toxic contaminant is present in the air at a high enough level to cause harm when it is inhaled. The damage may

occur immediately or it may take weeks, months or years for effects to surface. An immediate breathing hazard also exists when the air does not contain sufficient oxygen to support life.

WHICH ENVIRONMENTS ARE HAZARDOUS?

There are two types of environments in which the air may be hazardous to your health. The first is called an atmosphere **IMMEDIATELY DANGEROUS TO LIFE AND HEALTH** (IDLH). Air is considered IDLH when a person cannot escape unprotected in a few minutes without suffering fatal or serious injury. Air that does not have enough oxygen (less than 19.5 percent) and air containing high levels of toxic gases (such as carbon monoxide and hydrogen cyanide) are IDLH environments.

The second type of environment is considered NOT IMMEDIATELY DANGEROUS TO LIFE, but contains contaminants that can cause varied health effects ranging from irritation and discomfort to serious, irreversible damage as a result of repeated and/or prolonged exposure. Air having contaminants such as lead fumes or silica dust falls into this second category of hazardous environment. These substances produce little or no immediate health effects but over time can cause chronic disease.

NOTE: OSHA has a very strict set of parameters that define an IDLH atmosphere and the required level of respiratory protection. If investigators enter fire scenes immediately after overhaul, IDLH conditions could still exist requiring the use of positive-pressure SCBA. As an alternative, if the area is considered to be IDLH, proper ventilation of the atmosphere may reduce the level of harmful contaminants to a level that is deemed safe through air monitoring. At that time, respiratory requirements can be downgraded. In these instances, you are often left with an atmosphere contaminated with particulates and an approved particulate respirator can be used. Personnel should remember that the atmosphere determines the level of protection, not the type of task to be performed.

HOW CAN YOU PROTECT YOURSELF AGAINST RESPIRATORY HAZARDS?

By wearing the right type of respirator when necessary, you can protect your lungs from breathing hazards. The law requires that, if possible, engineering or administrative controls should be used to prevent air contamination at the workplace and reduce employee exposure below the Occupational Safety and Health Administration's (OSHA) Permissible Exposure Limits (PEL). However, if these controls are not possible, the employer is required to provide an appropriate type of respirator to the employee.

What Types of Respirators Are There?

Several types of respirators exist, each made for use in a specific hazardous environment. There are two basic types: air-purifying and air-supplying. Air-purifying respirators only remove harmful contaminants from the air, and must not be used in an oxygen-deficient environment or in any other IDLH atmosphere (e.g., fire suppression, hazardous materials incidents). Air-purifying respirators range from simple disposable masks to more sophisticated positive-pressure blower-operated respirators.

Air-purifying filters and cartridges have a limited lifespan and must be changed frequently. Dust filters must be changed when breathing becomes difficult due to clogging of filter pores by dust particles. Chemical cartridges/canisters must be changed before the chemical absorbent is used up, and this should be done under the guidance of a qualified person, such as an industrial hygienist.

Air-supplied respirators provide air from a clean source outside the work area or from a compressed air cylinder. They are used in IDLH environments and for substances with poor warning properties. Examples of air-supplied respirators include airline units, self-contained breathing apparatus (SCBA) and complete air-supplied suits.

Respirator face pieces come in two forms: full-face and half-mask. The full-face mask covers the face from hairline to chin and provides the most reliable fit, as well as eye protection against contaminants that are irritants or corrosives.

How Can The Right Respirator Be Selected?

Before any respirator can be selected, it is essential to know what the hazard is and how much is present. The organization should conduct a hazard and risk assessment to attempt to characterize the type(s) of environments and associated safety and/or health hazards. This should be completed prior to the selection, purchase and issuance of any respiratory protection equipment designed for the specific hazard(s) personnel are likely to encounter.

It is very important to know the functions and limitations of the respiratory protection devices that are issued. Selection of respirators must be made according to guidelines of the American National Standards Institute (ANSI) and Occupational Safety and Health Administration (OSHA). Proper respirator selection is a complicated process that does not always follow simple rules. If the wrong type of respirator is selected, workers will not receive adequate protection and the consequences can be serious.

What Degree of Protection do Respirators Provide?

The degree of respiratory protection varies greatly with the type of respirator and is indicated by the protection factor. The protection factor represents a respirator's efficiency in removing air contaminants from the worker's breathing air. It is the ratio of contaminant concentration outside the respirator to the concentration inside. The higher the protection factor, the better the efficiency. Protection factors for respirator types range from five for single-use disposable dust masks, to 10,000 for positive-pressure self-contained breathing apparatus (SCBA). OSHA can provide a list of the protective factors assigned to various respirators on request.

CHECKING THE RESPIRATOR FIT

Another important factor while wearing a respirator is having a good fit. A respirator can only protect a worker effectively if there is a good seal between the wearer's face and facepiece. A gap or poor seal will allow contaminants to leak into the respirator and be inhaled by the worker. Respirators that leak should not be worn.

To ensure that respirators fit correctly, fit-testing is essential. It must be performed for each worker to provide a style and size of respirator that provides the best individual fit and most comfort. Fit-testing cane be done by exposing the respirator wearer to an irritant smoke or odorous vapor (the respirator must have the proper cartridges for the test agent). If the wearer does not detect the agent in the facepiece, there is a good fit. This is known as the qualitative fit-test method. A second method is quantitative fit-testing that involves the use of an instrument to specifically measure the integrity of the face-to-facepiece fit to ensure that it is adequate. The respirator should also be fit-checked before each use to verify that a good seal exists. There are two easy checks that any worker can perform: the negative-pressure or positive-pressure tests.

The negative-pressure test is conducted by closing off the cartridge inlets on the respirator by covering them with the palms (or squeezing the breathing tube) and inhaling gently. If the nose of the facepiece collapses, the respirator fits adequately. In the positive-pressure test, with cartridges attached, the exhalation valve is closed off with one hand while the wearer exhales gently into the facepiece. The respirator is considered to have an adequate fit it its facepiece expands slightly as the wearer exhales into it without any evidence of outward leakage.

CAN EVERYONE USE RESPIRATORS?

A physician must first examine personnel required to wear a respirator on the job to determine whether they are physically fit. Since wearing a respirator imposes some stress on the user, people with conditions such as chronic bronchitis, emphysema, breathing difficulties, anemia and heart disease may not be permitted to wear respirators and therefore may be determined unfit for jobs that require wearing of a respirator. Workers with facial hair such as a beard (or long hair) or who wear an eyeglass temple piece that prevents a direct skin to facepiece seal also should not be permitted to use respirators.

HOW SHOULD RESPIRATORS BE MAINTAINED?

All respirators must be inspected before and after each use to detect any defect, deterioration or excessive wear or components. Special attention should be given to the facepiece, especially the face seal surface, cartridges (or canister) and exhalation valve. A check of the tightness of the connections must also be included in the inspection. If you are not familiar with the parts and functions of the respirator, a trained individual must perform inspection. Repairs must also be made only by a trained, qualified individual.

HOW OFTEN SHOULD RESPIRATORS BE CLEANED?

If you have been assigned a respirator for your exclusive use, the respirator must be cleaned regularly, preferably after each day's use. Those respirators used by more than one person must be thoroughly cleaned after each use. Respirators should be stored in an accessible, clean and sanitary location that should be provided by the employer. Cartridges or canisters should be stored in sealed plastic bags to prevent absorption of contaminants or moisture.

HOW OFTEN SHOULD RESPIRATOR CARTRIDGES/FILTERS BE REPLACED?

The replacement intervals depend on the substance to which the individual has been exposed and the length of exposure. As a general rule for dusts, when the person begins to have difficulty breathing, it's time to change the filter. Some respirators are equipped with an end-of-service-life indicator (ESLI) that provides a visual indication that the cartridge required replacement. Air-purifying filters and cartridges have a limited lifespan and must be changed frequently.

Dust filters must be changed when breathing becomes difficult due to clogging of filter pores by dust particles. Chemical cartridges/canisters must be changed before the chemical absorbent is used up, and this should be done under the guidance of a qualified person, such as an industrial hygienist.

For additional information concerning OSHA’s respiratory protection requirements, please refer to www.osha-slc.gov/SLTC/respiratoryprotection

In 1996, the National Institute of Occupational Safety and Health (NIOSH) completed a study of the respiratory hazards associated with fire investigations based on a health hazard evaluation (HHE) requested by the Bureau of Alcohol, Tobacco and Firearms (ATF). The NIOSH/ATF study included environmental monitoring of five fire scenes; two actual and three staged (controlled) fires in the Washington D.C. metropolitan area. During these fire scene scenarios, samples were collected for total and respirable dust, metals, hydrogen cyanide, inorganic acids, aldehydes (including formaldehyde), polynuclear armomatic hydrocarbons (PAHs), elemental carbon and volatile organic compounds (VOCs).

The monitoring results indicated that formaldehyde was detected at concentrations up to 0.18 parts per million (ppm). Two formaldehyde concentrations collected during the staged fire scenes exceeded the NIOSH recommended exposure limit of 0.1 ppm (ceiling). Low or trace concentrations of acetaldehyde, acrolein and furfural were also detected. NIOSH considers both formaldehyde and acetaldehyde to be potential occupational carcinogens. ***NIOSH concluded that fire investigator exposures to irritants that cause acute effects and carcinogens that have chronic effects are of concern. In addition, the use of respiratory protection and mechanical ventilation equipment can reduce the potential for exposure***. Several fire investigators who did not wear respiratory protection during the study experienced both eye and respiratory irritation.

Copies of the **ATF/NIOSH Health Hazard Evaluation (HETA-96-0171-2692)** can be downloaded at http://www2a.cdc.gov/hhe/hheresult.asp

Copies may also be downloaded from the DOWNLOADS Section of this web site.