



For many toxic chemicals, the respiratory (breathing) system is the quickest and most direct route of entry into the circulatory system. From the blood capillaries of the lungs, these toxic substances are rapidly transported throughout the body. Although the respiratory system does provide some filtration, small particles (less than 10 microns in diameter) can pass freely to the lungs. Additionally, if the person is exposed to a large concentration of particles, the body's ability to filter any size particle is reduced.

The key to preventing respiratory hazards associated with a pesticide application is to wear a respirator. Respirators protect applicators from inhaling airborne chemicals or dusts that may cause temporary or permanent harmful health effects, including death.

While the primary reason to wear a respirator is to protect your health, a secondary reason is that some pesticide product labels specify that a respirator be worn. Applicators are familiar with the phrase "the label is the law." You are legally required to follow all personal protective equipment (PPE) instructions on the label. The labeling often lists different PPE requirements for different activities. Usually, more

PPE is required for mixing and loading than for the application. In any case, if a label states that a specific respirator is to be worn, then not wearing that type of respirator is illegal.

Before wearing a respirator, it is recommended that you have a medical evaluation. Breathing through a respirator is extra work for your body. Respirators can be hazardous to people with heart and lung problems. Some people are claustrophobic or simply find that wearing a respirator is uncomfortable. Discovering any personal limitations before a pesticide application is better than finding one during an application.

Respiratory protective devices vary in design, use, and protective capability. In selecting a respiratory protective device, the user must first consider the degree of hazard associated with breathing the toxic substance and then understand the specific uses and limitations of the available equipment. Select a respirator that is designed for the intended use and always follow the manufacturer's instructions concerning the use and maintenance of that particular respirator. Different respirators may be needed for application of different chemicals or groups of chemicals. Only select equipment approved by the National Institute of Occupational Safety and Health (NIOSH) and the

Mine Safety and Health Administration (MSHA). The NIOSH/MSHA approval numbers begin with the letters TC (tested and certified). Most labels also indicate which TC cartridge provides the best protection for that product.

Types of Respirators

Respiratory protective devices can be categorized into two classes: air purifying and air supplied. An air-supplied respirator provides clean air for breathing from an independent compressed air supply. For example, the type of respirators firefighters and scuba divers use are air supplied. Since most pesticide contaminants can be removed from the atmosphere by air-purifying devices, we will look at these in greatest detail. They are the most commonly used in industry.

Air-purifying devices include nuisance dust masks, particulate air filters, gas masks (also referred to as canister filter respirators), chemical cartridge respirators, and powered air-purifying respirators. They can be used only in atmospheres containing sufficient oxygen to sustain life. In other words, they do not supply an independent source of air; they only filter the existing air. A characteristic of most air-purifying respirators is that they have negative pressure—the user's

respiratory system (lungs) must pull the air through the filter. A leak in the mask from a poor fit to the applicator's face or from a crack in the mask will allow contaminated air to bypass the filter, making the respirator ineffective. Therefore, a good seal and properly maintained equipment are essential.

Nuisance dust masks only provide relief from large dust particles and irritants and should only be used when dusts are not hazardous to your health. Nuisance dust masks are not considered protective devices. They offer minimal protection due to their poor sealing ability. This type of mask is *not* NIOSH approved since it will *not* protect you from hazardous dusts, gases, or vapors of pesticides.



Nuisance dust mask.

Particulate air filters are used for protection from particulates in the air but not for protection from chemical vapors or gases. Although particulate air filters may be used in some pesticide situations, they should never be used when mixing or applying pesticide liquids because splashed or spilled liquids or pesticide vapors can be absorbed by the mask and create an exposure hazard to the user.

In July 1995, NIOSH established performance criteria for particulate respirators. The criteria have three series of filter types: N (not resistant to oil), R (resistant to oil for up to 8 hours), and P (oil proof). The minimum efficiencies of 95, 99, and 99.97 percent indicate how efficient the respirator's filter capability is against particles that are at least 0.3 micrometers. For example, R99 is resistant to oil for up



Particulate air filter.

to 8 hours and will filter out 99 percent of the particles larger than 0.3 micrometers (Table 1).

Gas masks are usually full-facepiece respirators with one filtering canister. The full facepiece protects the eyes, nose, and mouth and provides a better seal than a half facepiece. The canister will last longer than chemical cartridge respirators when continuously exposed to some pesticides. A gas mask will not, however, provide protection when the air supply is low. A special respirator with a self-contained air supply should be worn in these situations.

Chemical cartridge respirators provide respiratory protection against certain gases and vapors in concentrations not greater than 0.1 percent by volume, provided that this concentration does not exceed an amount that is immediately dangerous to life and health. More specifically, they are for use only when exposure to light concentrations of chemicals is likely, such as when mixing pesticides outdoors.



Gas mask.

Cartridge respirators are available either as half-masks, covering only the nose and mouth, or as full-facepiece respirators for both respiratory and eye protection. Some respirators offer a combination of both a chemical cartridge and a mechanical filter (prefilter). This combination can provide respiratory protection against gases and particulate matter.

No single type of cartridge is able to remove all kinds of chemical vapors. A different type of chemical cartridge



Chemical cartridge respirator.

Table 1. Particulate filter series codes.

Code	Filter series	Filter type designation	Minimum efficiency (%)
N	Not resistant to oil	N95	95
		N99	99
		N100	99.97
R	Resistant for up to 8 hours	R95	95
		R99	99
		R100	99.97
P	Oil proof	P95	95
		P99	99
		P100	99.97

(or canister) must be used for different contaminants. For example, cartridges and canisters that protect against certain organic vapors differ chemically from those that protect against ammonia gases. Be sure that the cartridge or canister is approved for the pesticide you intend to use (check the product label). Cartridge respirators are not recommended for use against chemicals that possess poor warning properties. Thus, the user's senses (smell, taste, irritation) must be able to detect the substance at a safe level if cartridge respirators are to be used correctly.

The effective life of a respirator cartridge or canister depends on the conditions associated with its use, such as the type and concentration of the contaminants, the user's breathing rate, and the humidity, as well as its gas and vapor sorption capacity. When the chemical cartridge becomes saturated, a contaminant can pass through the cartridge, usually allowing the user to smell it. At this point, the cartridge must be changed immediately. Periodically, the mechanical prefilter also needs to be changed. A prefilter should be replaced whenever the respirator user feels that breathing is becoming difficult. Dispose of all spent cartridges to avoid their being used inadvertently by another applicator who is unaware of their contaminated condition.

Chemical cartridge respirators cannot provide protection against extremely toxic gases such as hydrogen cyanide, methyl bromide, or other fumigants. Masks with a self-contained air supply are necessary for these purposes.



Powered air-purifying respirator.

Powered air-purifying respirators (PAPR) equipped with pesticide filters/cartridges also are effective in filtering out pesticide particles and vapors. They are available as full-face masks, hoods, or protective helmets, which are connected to a battery-powered filtration system by a breathing hose. PAPR have the advantage of being positive pressure. Contaminated air is forced through the filter, resulting in purified air running through a hose to the helmet/headpiece. The entire head area is surrounded by filtered air and has the additional benefit of cooling the person wearing it. Moreover, because of the positive pressure, if there is a leak, filtered air will be forced out through the leak and not allow contaminated air to enter. But, as with other air purifying devices, this system does not supply oxygen and must be worn only when the oxygen supply is not limited.

Table 2 compares the five types of air-purifying respirators based on NIOSH approval, certification markings, filters chemical gases and vapors, particle size



Powered air-purifying respirator.

capability, positive or negative pressure, and overall protection assessment.

Use and Care of Respirators

Respirators are worn as needed for protection when handling certain pesticides. Prior to using a respirator, read and understand the manufacturer's instructions with the equipment, on the cartridge, or canister and all supplemental information about its proper use and care. Be sure the filter is approved for protection against the pesticide you intend to use. Respirators labeled only for protection against particulates must not be used for gases and vapors. Similarly, respirators labeled only for protection against gases and vapors should not be used for particulates. Remember, cartridges and filters do not supply oxygen. Do not use them where oxygen may be limited.

Table 2. Comparison of air-purifying respirators.

	Nuisance dust mask	Particulate air filter	Gas mask	Chemical cartridge respirator	Powered air-purifying respirator
NIOSH approved	No	Yes	Yes	Yes	Yes
Certification markings	No	Yes	Yes	Yes	Yes
Filters chemical gases and vapors	No	No	Yes	Yes	Yes
Particle size capability	10 microns	0.3 micron	0.3 micron	0.3 micron	0.3 micron
Positive or negative pressure	Negative	Negative	Negative	Negative	Positive
Overall protection	None	Some	Good	Good	Best

All respirators must be inspected for wear and deterioration of their components before and after each use. Special attention should be given to rubber or plastic parts, which can deteriorate. The facepiece, valves, connecting tubes or hoses, fittings, and filters must be maintained in good condition.

All valves, mechanical filters, and chemical filters (cartridges or canisters) should be properly positioned and sealed. Fit the respirator on your face to ensure a tight but comfortable seal. A beard or large sideburns may prevent a good face seal.

Fit-check your respirator before each use to minimize contaminant leakage into the facepiece. Two tests can be done to check the fit of most chemical cartridge respirators. The first test requires that you place your hand tightly over the outside exhaust valve. If there is a good seal, exhalation should cause slight pressure inside the facepiece. If air escapes between the face and facepiece, readjust the headbands until a tight seal is obtained. Readjusting the headbands may not be sufficient at times to obtain a good seal. The facepiece may need to be repositioned to prevent air from escaping between the face and facepiece. The second test involves covering the inhalation valve(s) by placing your hand over the cartridge(s). If there is a good seal, inhalation should cause the facepiece to collapse. If air enters, adjust the headbands or reposition the facepiece until a good seal is obtained.

When a good seal is not maintained or high contaminant concentrations exceed the respirator's capacity, get to fresh air immediately. Typical signals to the applicator include the following:

- Begin to smell or taste contaminants
- Eyes, nose, or throat become irritated
- Breathing becomes difficult
- Air being breathed becomes uncomfortably warm
- Nausea or dizziness

After each use of the respirator, remove all mechanical and chemical filters.

Wash the facepiece with soap and warm water, and then immerse it in a sanitizing solution such as chlorine bleach (two tablespoons per gallon of water) for two minutes, followed by a thorough rinsing with clean water to remove all traces of soap and bleach. Wipe the facepiece with a clean cloth and allow to air-dry.

Store the respirator facepiece, cartridges, canisters, and mechanical filters in a clean, dry place, preferably in a tightly sealed plastic bag. *Do not store respirators with pesticides or other agricultural chemicals.* Handle respirators with the same care that you give your other protective equipment and clothing.

References and More Information

Respiratory Protection eTool, U.S. Department of Labor: www.osha.gov/SLTC/etools/respiratory/index.html

NIOSH Guide to the Selection and Use of Particulate Respirators Certified Under 42 CFR 84: www.cdc.gov/niosh/userguid.html (click on I. Summary for Respirator Users)

Farm Respiratory Protection, Penn State Department of Agricultural and Biological Engineering: www.age.psu.edu/extension/factsheets/e/e36.pdf

Pesticide Safety Fact Sheets are produced by the Pesticide Education Program in Penn State's College of Agricultural Sciences. Topics covered in the series include

- pesticide laws and regulations
- handling chemical spills
- personal protective gear
- pesticides in the environment
- equipment care and cleaning
- pesticide toxicity and health effects

For a complete list of fact sheets and electronic copies or for more information about the Pesticide Education Program, please visit www.pested.psu.edu on the Web.

Poison Control Centers 1-800-222-1222

Calling the toll-free National Poison Center hotline above will connect you to the nearest poison center. Pennsylvania residents are served by the Pittsburgh Poison Center and the Poison Control Center in Philadelphia.

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