

# Personal Protective Equipment for Handling Pesticides<sup>1</sup>

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*This document describes various articles of personal protective equipment (PPE) that are worn to protect the human body from contact with pesticides or pesticide residues. PPE includes such items as coveralls or protective suits, footwear, gloves, aprons, respirators, eyewear, and headgear.*

## Introduction

Pesticides can pose hazards to humans. Hazard depends on the product's toxicity and length of exposure. The severity of a pesticide poisoning depends on the pesticide's chemical makeup and formulation, its path into the body, the amount that enters the body, and the length of exposure. Wearing PPE can greatly reduce the potential for dermal, inhalation, eye, and oral exposure, and thereby significantly reduce the chances of a pesticide poisoning, but does not necessarily eliminate it.

All pesticide handlers—applicators, mixer/loaders, flaggers, and early-entry agricultural workers—are legally required to follow all PPE instructions that appear on the product label. A pesticide label lists the minimum PPE that a person must wear while performing handling or early-entry activities (Figures 1 and 2).

### PRECAUTIONARY STATEMENTS

#### Hazards to Humans (and Domestic Animals)

May be fatal if swallowed. Harmful if inhaled or absorbed through skin. Causes moderate eye irritation. Avoid breathing vapor or spray mist. Avoid contact with skin, eyes or clothing.

#### Personal Protective Equipment:

Applicators and other handlers (other than mixers and loaders) must wear:

- Long-sleeved shirt and long pants
- Waterproof gloves
- Shoes plus socks

#### Mixers and Loaders must wear:

- Long-sleeved shirt and long pants
- Waterproof gloves
- Shoes plus socks
- Protective eyewear

Figure 1. Typical PPE required for handlers to wear according to label directions.

### AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted-entry intervals. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water is: Coveralls; Waterproof gloves; and Shoes plus socks.

Figure 2. Typical PPE required for early entry workers to wear according to label directions.

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## Chemical-Resistant Clothing

The term *chemical-resistant* means that no measurable movement of the pesticide through the material occurs during the period of use. Some PPE is water resistant only. PPE that is *water resistant* will prevent a small amount of fine spray particles or small liquid splashes from penetrating the clothing and reaching the skin. *Waterproof* (liquid-proof) material keeps water-soluble materials out, but it may not necessarily keep out oil solvent-based products. Waterproof materials include items made of plastic or rubber. The chemical resistance of a material is an indication of how strongly it resists chemical penetration by pesticide products during use.

Always read the pesticide labeling to see if it states which materials are resistant to the pesticide product. In some instances, a pesticide label's PPE description lists a code letter (A-H) developed by the EPA to help the user select suitable PPE (Figure 3). The EPA Chemical Resistance Category Selection Chart is given in Table 1.

### PERSONAL PROTECTIVE EQUIPMENT (PPE)

Some of the materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category A on an EPA chemical-resistance category chart.

**Applicators and other handlers must wear:** long sleeved shirt and long pants, shoes plus socks, and chemical resistant gloves made of any waterproof material such as polyethylene or polyvinyl chloride.

Figure 3. PPE label statements based on the EPA Chemical Resistance Category Selection Chart.

The chart's code letters are based on the solvents used in a pesticide product, *not* the pesticide's active ingredient. By referring to this chart, a pesticide handler can determine how long a given material can be expected to withstand chemical exposure by a given solvent. For example, the label directions from Figure 3 advise handlers to "refer to Category A on an EPA chemical resistance category chart." Based on the chart's recommendations, any of the materials listed would be suitable for handling this product.

## Protect Your Skin

According to an EPA report, most pesticide poisoning incidents occur through pesticides contacting the skin. PPE is protective only when used properly. If pesticide gets inside PPE next to the skin, the PPE will no longer protect the wearer. On the contrary, it will hold the pesticide against the skin as long as it is worn, increasing rather than decreasing the likelihood of contact injury or skin absorption and systemic injury.

## Work Clothes

Ordinary shirts, pants, shoes, and other work clothes are usually not considered PPE, even though pesticide labels often indicate that specific items of work clothing should be worn during certain activities. The work clothes should be made of sturdy material and must be free of holes and tears. Shirt collars should be fastened completely to protect the lower part of the neck. The tighter the fabric weave, the better the protection. In some instances, the product label requires wearing a coverall, a chemical-resistant suit, or a chemical-resistant apron over work clothes.

## Coveralls

The protection offered by chemical-resistant clothing depends on the fabric, and on design features such as flaps over zippers, elastic at the wrists and ankles, and seams that are bound and sealed. Coveralls should be made of sturdy material such as cotton, polyester, a cotton-synthetic blend, denim, or a non-woven fabric such as Tyvek® (Figures 4–6). When wearing a coverall, the opening should be closed securely so the entire body, except the feet, hands, neck, and head, is covered. With two-piece outfits, the shirt or coat should not be tucked in at the waist, but rather the shirt should extend well below the waist of the pants and fit loosely around the hips. Well-designed coveralls offering protection from pesticides are tightly constructed and have sealed seams and snug, overlapping closures that do not allow gaps and do not unfasten readily. For example, many coveralls have zippers that are covered by flaps for added protection. Some coveralls, such as those made of Tyvek®, are water resistant and disposable.



Figure 4. Synthetic blend coveralls.





Figure 5. Cotton coveralls.



Figure 6. Tyvek coveralls.

## Chemical-Resistant Suit

Some product labels require the handler to wear a chemical-resistant suit. This usually indicates the pesticide is very hazardous because of either acute or delayed effects. Chemical-resistant suits made of rubber or plastic are sold as one-piece coveralls or as two-piece outfits consisting of a jacket worn over coveralls. Chemical-resistant suits made of coated, non-woven fabric usually are sold as one-piece coveralls. The biggest drawback to chemical-resistant suits is they make the body uncomfortably warm. In Florida's climate, heat stress becomes a major concern.

## Chemical-Resistant Apron

An apron protects from splashes and spills, and it protects coveralls or other clothing. Aprons should be considered whenever pesticide concentrates are handled. The pesticide

label may require wearing a chemical-resistant apron when mixing or loading a pesticide or when cleaning application equipment. Some aprons are heavily constructed, but lightweight, disposable aprons are also commercially available (Figures 7–8).

An apron can pose a safety hazard when working around equipment with moving parts. In that situation, a chemical-resistant suit would be a better choice.



Figure 7. Some labels state that a chemical-resistant apron should be worn while cleaning application equipment.



Figure 8. Some aprons are very lightweight and disposable.



## Gloves

The parts of the body that get the most exposure to pesticide are the hands and forearms. Research has shown that workers mixing pesticides received 85 percent of the total exposure to hands and 13 percent to the forearms. The same study showed wearing gloves reduced exposure by at least 98 percent to applicators who had spills while mixing or applying pesticides (Table 2). As a result, most product labels require use of waterproof or chemical-resistant gloves during handling and mixing. Gloves should be worn any time pesticides may contact hands, such as when working around contaminated equipment or surfaces (Figure 9).



Figure 9. Gloves should be worn while washing contaminated application equipment.

Polymers used for chemical-resistant gloves (Figures 10–15) include those materials listed in Table 1. These materials are used either individually or in various combinations in commercially available gloves. Canvas and leather gloves will not protect against exposure to pesticides because these materials absorb pesticide easily and cannot be decontaminated.



Figure 10. Barrier laminate gloves.



Figure 11. Butyl rubber gloves.



Figure 12. Nitrile rubber gloves.



Figure 13. Neoprene rubber glove in two styles-the upper has a textured-surface for better gripping.



Figure 14. Natural rubber gloves.





Figure 15. Polyvinyl chloride gloves.

Chemical-resistant gloves are fabricated in two forms. One is that of the hand silhouette. This glove is made by die-cutting a two-dimensional outline of a hand from a plastic film. Two of these flat hand forms are welded around the edges to form a glove. Most gloves made from polyethylene are constructed in this manner. The hand-silhouette gloves can be ineffective because of poor fit, loss of dexterity, and difficulty in keeping the gloves on the hands. The second and more common type of chemical-resistant glove is made by dip molding, that is, by dipping a hand mold into a polymer-containing liquid. Dipped gloves are right- and left-handed and are sized. These gloves provide both a better fit and improved dexterity. Some of the dipped gloves come with curved fingers, which provide additional comfort.

Glove thickness is described in units of mils (1 mil = 0.001 inch). In general, the effectiveness of the barrier and its resistance to tear and puncture increases with thickness. Commercially available gloves range in thickness from 1 to 60 mils. The most commonly used chemical-resistant gloves range from 12 to 22 mils.

## Footwear

Pesticide handlers may get pesticides on their feet. Shoes and socks are often sufficient to protect your feet during many handling activities. When handling certain pesticides, however, canvas and leather shoes offer insufficient protection for the same reasons gloves made of these materials are not protective. The product labels for those pesticides require wearing waterproof or chemical-resistant footwear, which could mean shoe covers (Figure 16) or boots.

If a pesticide is likely to get on the lower legs or feet, chemical-resistant boots that extend past the ankles and at least halfway up to the knee should be worn. Wear

waterproof boots when entering or walking through recently treated areas such as lawns before the spray has dried.



Figure 16. Shoe covers designed for use while handling pesticides.

## Wear Gloves and Footwear Correctly

Chemical-resistant gloves and footwear should not be worn when handling certain fumigants. The gloves and footwear can trap the fumigant gas near the skin and cause burns (Figure 17). Like other pesticides, fumigant labels specify the appropriate PPE required to protect the applicator from exposure.



Figure 17. Skin blistered by fumigant exposure to the foot.

If removing non-disposable gloves during a handling activity, the gloves should be thoroughly washed before removal. For jobs in which the arms are mostly lowered, the sleeves should be placed outside the gloves to prevent pesticide from running down into the gloves and onto the skin of the hands. For jobs in which the arms are mostly raised, gloves should remain outside the sleeves. Likewise, similar precautions should be observed with pant legs and boots. Pant legs should be outside of the boots to prevent pesticides from running down into the boots (Figure 18).





Figure 18. Pant legs should be outside of the boots, not inside as shown here, to prevent pesticide from running down into the boots.

## Overhead Protection

For overhead exposure or exposure to airborne particles, there are several PPE options. A plastic safari hat with plastic sweatbands is a good choice in hot weather. More flexible hats and hoods are also available in chemical-resistant materials (Figure 19).

Hats must not contain absorbent material such as cotton, leather, or straw. Many chemical-resistant jackets or coveralls can be purchased with attached protective hoods.



Figure 19. Flexible, lightweight chemical-resistant hat.

## Protect Your Eyes

Eyes are very sensitive to the chemicals contained in some pesticide formulations, especially concentrates. Goggles, face shields, and safety glasses with shields at both the brow and sides are examples of protective eyewear (Figure 20–22).



Figure 20. Goggles.



Figure 21. Full face shield.

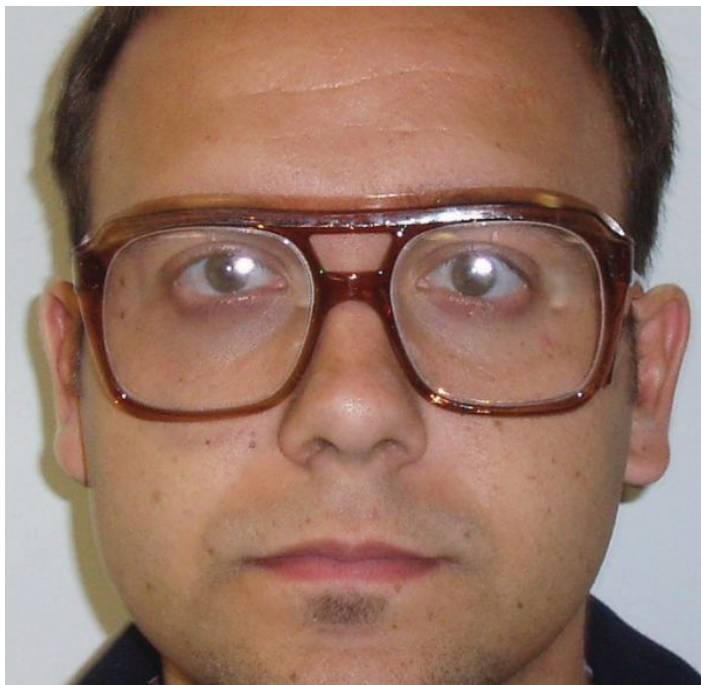


Figure 22. Shielded safety glasses.



Shielded safety glasses and full face shields are good choices in many handling situations because they are relatively comfortable, do not cause fogging or sweating, and provide good eye protection. If goggles will be worn, materials made of polycarbonate that have protected air baffles to avoid fogging are the most comfortable choice. Either goggles or shielded safety glasses can be worn with a half-face respirator (Figure 23).



Figure 23. Wearing goggles with a half-face respirator.

If the Worker Protection Standard applies and if the label specifies goggles for eye protection, then regulations pertaining to eyewash decontamination are in effect.

## Protect Your Respiratory Tract

Respirators protect from breathing pesticide-contaminated air. Various pesticide formulations require different types of respirators. The label will provide specific instructions if required, and if so, which type (Figure 24).

Personal Protective Equipment (PPE)	
Applicators and other handlers (other than Mixers and Loaders) must wear:	
<ul style="list-style-type: none"> <li>Long-sleeve shirt and long pants</li> <li>Shoes plus socks</li> <li>Protective eyewear</li> <li>Chemical Resistant Gloves - Category A (e.g. barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinyl chloride (PVC) or Viton®)</li> <li>A dust mist NIOSH-approved respirator with any N, R, P, or HE filter</li> </ul>	
Mixers and Loaders must wear:	
<ul style="list-style-type: none"> <li>Long-sleeve shirt and long pants</li> <li>Shoes plus socks</li> <li>A dust mist NIOSH-approved respirator with any N, R, P, or HE filter</li> <li>Chemical Resistant Gloves - Category A (e.g. barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinyl chloride (PVC) or Viton®)</li> <li>Chemical resistant apron</li> <li>Face shield</li> </ul>	
Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.	

Figure 24. If a respirator is required, the label will specify the type.

Respirators are the most specialized piece of personal protective equipment for working with pesticides, and proper selection is complicated. Specific information on choosing the appropriate respirator will be supplied by pesticide labels. Use only respirators approved by the

National Institute of Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA). Approved respirators will carry a "TC" number prefix, which signifies they have been tested and certified for a specific level of protection. If you plan to purchase a new respirator, a particulate respirator that formerly carried a TC-21C NIOSH prefix may carry a TC-84A prefix. NIOSH has developed a set of regulations in 42 CFR 84 (also referred to as "Part 84") for testing and certifying non-powered, air-purifying, particulate-filter respirators. The Part 84 respirators have passed a more demanding certification test than the old respirators (e.g., dust and mist [DM], dust, fume, and mist [DFM], spray paint, pesticide, etc.) certified under 30 CFR 11 (also referred to as "Part 11"). The following is a list showing several types of respirators and their TC code designations under the NIOSH classification system:

- TC-84A: non-powered particulate respirators (N, P, and R filters).
- TC-21C: powered particulate respirators only (100 series filters).
- TC-23C: chemical cartridge respirators.
- TC-14G: gas masks with canisters.
- TC-19C: supplied-air respirators.
- TC-13F: self-contained breathing apparatus.

Particulates are solid particles such as dusts and mists. Pesticide labels that specify organic vapor-removing cartridge respirators will also list which filters or pre-filters can be used with the respirator. The filters are identified by codes such as an HE, N, R or P, which indicate the level of oil resistance offered by the filter. "N" filters are not resistant to oils, but are excellent for use with dusts and granular formulations. "R" and "P" filters are either oil-resistant (R) or oil-proof (P). HE filters refer to "high efficiency" filters for powered-air purifying units, which can be used with oils. Manufacturers will designate a number that follows the HE, N, R, or P on their products, and this number is an indication of the trapping efficiency. For example, a particulate respirator or filter with the N95 designation would be expected to have 95 percent efficiency in its trapping capacity. Pesticide label recommendations generally instruct the user to have a P100 filter with the chemical cartridge respirator when handling and applying oil-based pesticides.

One of the two common types of respirators is the air-purifying respirator. Some air-purifying respirators cover the entire face; there are also less expensive half-masks

that cover the nose and mouth. These respirators should be used only where there is sufficient oxygen. Air-purifying respirators have chemical cartridges or mechanical filters to remove airborne contaminants as air enters the respirator. The chemical cartridges are filled with activated carbon, which has a very high absorption capacity for gases and vapors. Each chemical cartridge is color-coded to indicate the use for which it was designed. A description of these codes is listed in Table 3. Mechanical filters provide protection by trapping particulate matter in the porous filter material.

Most air-purifying respirators (Figures 25–26) operate under negative pressure; that is, they rely on the power of the wearer's lungs to pull air through the filter elements. These include half-mask dust/mist respirators, half-mask dual-cartridge respirators, full-face dual-cartridge respirators, and canister-type gas masks. Dust/mist respirators (Figure 27) and some half-mask dual-cartridge respirators are disposable. The only air-purifying respirator that operates under positive pressure is the powered air-purifying respirator (PAPR). It has a fan that pulls air through the filters and circulates it over the wearer's face. Air-purifying respirators vary widely in price.

The second basic type of respirator is the atmosphere-supplying respirator. This kind of respirator supplies an independent source of breathable air and is used in conditions where oxygen is deficient or the applicator is exposed to high concentrations of very toxic pesticides in enclosed areas. Breathable air is supplied to the wearer from an independent source through an air line, or the wearer carries oxygen in a tank. These respirators are relatively expensive and should be serviced and inspected by qualified personnel.

An applicator should perform a fit test to determine correct size of a respirator face piece because a respirator that does not provide a proper seal is of little value. OSHA mandates that a fit test be performed every time a person puts on a respirator. Instructions for conducting fit tests generally accompany half-mask and full-face respirators.

Chemical cartridges should be replaced according to the manufacturer's recommendations or the pesticide label, or when the wearer notices odor or experiences irritation. Pre-filters will extend the life of chemical cartridges in dusty conditions. Mechanical filters should be replaced when breathing becomes difficult or the filter is damaged, or as specified by the manufacturer or the pesticide label. If no instructions are provided, replace cartridges and filters when the workday is over.



Figure 25. Air-purifying respirator.



Figure 26. Air-purifying respirator.

## Maintaining Personal Protective Equipment

When a pesticide-handling activity is completed, PPE should be removed right away. The outside of the gloves should be washed with detergent and water before removing the rest of the PPE. Then, the outside of the other chemical-resistant items should be washed before removing the gloves.





Figure 27. Dust/mist respirator.

## Disposables

Disposable PPE items are not designed to be cleaned and reused, and should be discarded when they become contaminated with pesticides. Chemical-resistant gloves, footwear, and aprons labeled as disposable are designed to be worn only once and then thrown away. These items are made of thin vinyl, latex, or polyethylene. These inexpensive disposables may be a good choice for brief pesticide-handling activities that require dexterity, as long as the activity does not tear the thin plastic.

## Reusables

Some PPE items, such as rubber and plastic suits, gloves, boots, aprons, capes, and headgear, are designed to be cleaned and reused several times. However, they should not continue to be worn when they no longer are able to provide adequate protection. They can be checked for rips and leaks by using the rinse water to form a “balloon” and/or holding the items up to the light. Even if there are no obvious signs of wear, reusable PPE items should be replaced regularly. The ability of a chemical-resistant material to resist pesticides decreases each time the item is worn. A good rule of thumb is to throw out gloves that have been worn for about 5 to 7 workdays. Extra-heavy-duty gloves, such as those made of butyl or nitrile rubber, may last as long as 10 to 14 days. The cost of frequently replacing gloves is a wise investment. Footwear, aprons, headgear, and protective suits may last longer than gloves because they generally receive less exposure to the pesticides and less

abrasion from rough surfaces. Most protective eyewear and respirator bodies, face pieces, and helmets are designed to be cleaned and reused. These items can last many years if they are of good quality and are maintained correctly.

## Washing PPE

Pesticide-contaminated items should be washed separately from the family laundry. The following procedure can be used for washing non-chemical-resistant items such as cotton, cotton/polyester, denim, canvas, and other absorbent materials, and for most chemical-resistant items.

### Procedure for Washing Contaminated PPE

1. Wash only a few items at a time so there is plenty of agitation and water for dilution.
2. Wash in a washing machine, using heavy-duty liquid detergent and hot water for the wash cycle. Set the washer to the longest wash cycle and two rinse cycles.
3. Use two entire machine cycles to wash items that are moderately to heavily contaminated. If PPE is too contaminated, bundle it in a plastic bag, label the bag, and take it to a household hazardous waste collection site.
4. Run the washer through at least one additional entire cycle without clothing, using detergent and hot water, to clean the machine before any other laundry is washed.
5. Hang the washed items to dry, if possible. It is best to let them hang for at least 24 hours in an area with plenty of fresh air.

## Maintaining Eyewear and Respirators

Wash goggles, face shields, shielded safety glasses, respirator bodies, and face pieces after each day of use. Use detergent and hot water to wash them thoroughly. They should be sanitized by soaking for at least 2 minutes in a mixture of 2 tablespoons of chlorine bleach in 1 gallon of hot water, then rinsed thoroughly. Following rinsing, the items should be allowed to dry thoroughly by hanging them in a clean area. Store respirators and eyewear in an area where they are protected from dust, sunlight, extreme temperatures, excessive moisture, and pesticides or other chemicals. A sturdy plastic bag with a zip closure works well for storage (Figure 28).



Figure 28. Store respirators and cartridges in an airtight bag, or they may lose their effectiveness.

## Additional Information

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Table 1. EPA chemical-resistance category selection chart.

Selection Category on label	Type of Resistant Material							
	Barrier laminate	Butyl rubber ≥ 14 mils	Nitrile rubber ≥ 14 mils	Neoprene rubber ≥ 14 mils	Natural rubber* ≥ 14 mils	Polyethylene	Polyvinyl chloride (PVC) ≥ 14 mils	Viton ≥ 14 mils
<b>A</b> Dry and water-based formulations	High	High	High	High	High	High	High	High
<b>B</b>	High	High	Slight	Slight	None	Slight	Slight	Slight
<b>C</b>	High	High	High	High	Moderate	Moderate	High	High
<b>D</b>	High	High	Moderate	Moderate	None	None	None	Slight
<b>E</b>	High	Slight	High	High	Slight	None	Moderate	High
<b>F</b>	High	High	High	Moderate	Slight	None	Slight	High
<b>G</b>	High	Slight	Slight	Slight	None	None	None	High
<b>H</b>	High	Slight	Slight	Slight	None	None	None	High

\* Includes natural rubber blends and laminates.  
**High:** Highly chemically resistant. Clean or replace PPE at end of each day's work period. Rinse off pesticide at breaks.  
**Moderate:** Moderately chemically resistant. Clean or replace PPE within an hour or two of contact.  
**Slight:** Slightly chemically resistant. Clean or replace PPE within 10 minutes of contact.  
**None:** Not chemically resistant. Do not wear this type of material as PPE when contact is possible.

Table 2. Average urinary glyphosate concentration values on the day of application according to use of rubber gloves.

Activity	Use of Rubber Gloves	
	Yes	No
	Concentration (ppb)	Concentration (ppb)
Spill while mixing	4.1	232.7
Spill while applying	3.6	153.6

Table 3. Chemical cartridge color codes.

Color	Protects against...
Black	Organic vapors (pesticides except fumigants unless allowed on label), paint spraying (except isocyanate-containing paints), fumigation
Green	Ammonia: anhydrous or from livestock confinement
Yellow	Acid gases, such as chlorine and other disinfectants
Olive*	Organic vapors, ammonia, and acid gases
Pink	Dusts and welding fumes

\*Relatively short life against pesticides.