



Respirators 101

Selecting Respiratory Protection for Pesticide Applications

Garnet Cooke
Pesticide Coordinator,
Oregon OSHA



Respirators 101

Introduction:

Most everyone has experience dealing with some kind of filters. Filters are used in heating systems, vehicles and even the lawn mower. On the very basic level they protect the engine of choice from being choked with contaminants so that the engine continues to run. If these filters are not maintained or changed, the engines cannot function, which is not unlike those filters we strap to our face.

People throughout time have fashioned a wide variety of devices to allow themselves to breathe easier and protect their nose, throat and lungs. This has led to the development of a variety of filters for a variety of contaminants. Some filters are quite protective, others are less so, and some even are down right dangerous if used in the wrong situations. With so many options it is easy to get confused.

When it comes to pesticides and respirators you add regulations and oversight by three different Federal Agencies who don't communicate well with each other, which makes the confusion worse. In addition, some respirator retailers use respirator descriptions that do not match those used by federal agencies. One thing is for certain, all this confusion means people who work with or near pesticides have many questions about what respirators they are required to use and how to use them to be safe. .

➤ Why are pesticide labels so confusing?

Pesticide labels are confusing because the terminology used to describe respirators is more complex than other pesticide personal protective equipment and a lack of communication between three government agencies on how to use that terminology on pesticides labels. Corrections to this problem are currently underway. In the meantime there are over 2500 labels with quirky language.

Who are the three agencies that deal with respirators?

- 1) The National Institute for Occupational Health and Safety (NIOSH) approves respirators.
- 2) The Occupational Health and Safety Administration (OSHA) regulates the use of respirators in the workplace.
- 3) The United States Environmental Protection Agency (EPA) regulates pesticides and pesticide labels and requires the use of respirators on pesticide labels when necessary to protect human health.

How confusing is it? In past handler videos, it shows a "dust/mist" mask with two straps having the NIOSH Approval number TC-21C. Now a powered air purifying respirator is the only one with that approval! What is up with that?

Previously both the “dust mist” two strap mask and the PAPR shared the TC-21C approval, but NIOSH moved the approval for the “dust/mist” mask with two straps to TC-84A, leaving only the particulate powered air purifying respirator under the TC-21C designation.



Formerly TC-21C



TC-21C

To make it easier to weed through the confusion over respirator selection, it is best to understand the components of a respirator and how they work. (Don't worry: there will be a decoder!)

We will look at the types of respirators, their components, a little interesting history and the importance of the “NIOSH Approval Number Prefix”.

Types of Respirators: There are two types of respirators- air supplying and air purifying.

Air Supplying:

What is a supplied air respirator?

A supplied air respirator provides you with clean air from an uncontaminated source. Examples are Self Contained Breathing Apparatus (SCBA) and Air-line respirators. An SCBA has air in a tank, and an air-line respirator pumps air through a line into the face-piece.

Points to Ponder:

You pack an SCBA on your back and you are limited to the amount of air in the tank. An SCBA is used when the air contaminants are unknown, or when the concentration in the air is at a level that is Immediately Dangerous to Life or Health (IDLH) or, as the firemen call it “I Don't Leave Here.” This situation can occur when working with certain fumigants.

With an “Air Line” respirator a significant issue exists if your air line gets pinched.



SCBA



Air Line with escape bottle

Air-purifying

Air purifying respirators function by mechanically filtering out the air contaminant. They can be used to protect against particulates, vapors or gases. And if those choices weren't enough, the filters, cartridges or canisters attach to a variety of face pieces. The filter might be the entire unit, as in a filtering face piece or the filters might attach to a half- or full face unit, or even to a powered air purify respirator. Some are tight-fitting, others fit loosely around the head.

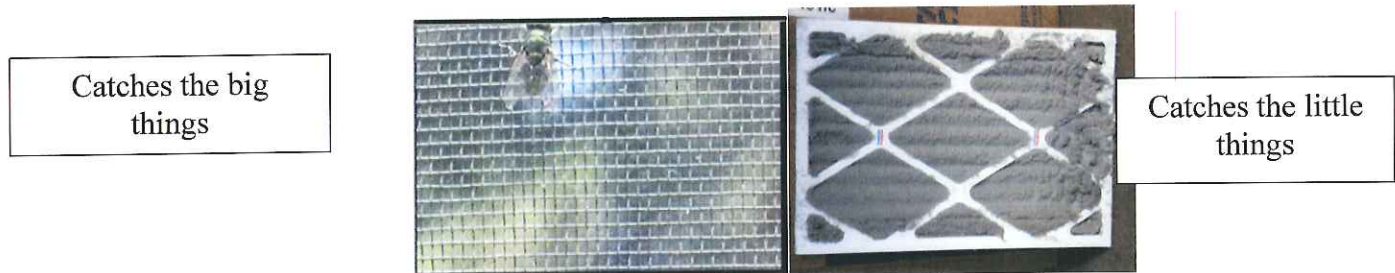
➤ Know some details about the air contaminant

To select the proper filtering mechanism you have to understand some details (behaviors) of the air contaminant in order to capture it.

Particulates

Particulates are minute solid or liquid particles of mineral or organic origin that are either deposited on surfaces or suspended in air. Solid particulates were formally known as dust. Mist is condensed water vapor, a fine spray, a liquid contaminant, or a smoke-like fume suspended in the air. To protect against solid particulates and mists particulate filters are used.

➤ Know the difference between the filtering mechanisms



What are the differences between N, R and P filters, and what do the numbers 95, 99 and 100 mean?

N - is Not resistant to oils

R - is Resistant to oils but has a time use limit

P - means strongly resistant to oil or oil Proof

The numbers denote the efficiencies of the filter: 95 means a filter can remove 95% of the most penetrating particle size, 99 removes 99% and those that filter out 99.97%, essentially 100% receive a 100 rating.

What is an "HE" filter?

HE stands for high efficiency and can only go on a powered air purifying respirator (PAPR) due to the dense nature of the filter media.

Does the shape/size of a particulate filter (pancake or cartridges) matter?

No.

When do I have to change filters?

a) When breathing becomes resistance becomes excessive (difficult).

- b) When the filter element has physical damage or tears.
- c) According to the manufacturer's recommendations or the pesticide labeling, whichever is more frequent.
- d) In the absence of any other instructions or indications of service life, at the end of eight hours of cumulative use.



Photo credit: en.wikipedia.org

Can you wash filters?
No!

What is the difference between a particulate filter and an organic vapor cartridge?

A particulate filter protects against particles, and an organic vapor cartridge contains activated charcoal which the organic vapors adhere to, effectively protecting the lungs.

Gases and Vapors

What is an organic vapor?

Organic vapors are those vapors containing carbon, which includes most - but not all - pesticides. Organophosphates are just one type of pesticides that produce organic vapors. An organic vapor cartridge or canister contains activated charcoal which protects against certain organic vapors. When a pesticide label requires an organic vapor cartridge, it will usually call for an additional combination filter for particulates that is **attached** to the organic vapor cartridge. A canister has the particulate protection **included** in the canister.

What is activated carbon?

The primary raw material used for the production of activated carbon is bituminous coal that is crushed, sized and processed in low temperature bakers followed by high-temperature furnaces. In addition, coconut shells are also used. This heating process is known as activation, and develops the pore structure of the carbon. Through adjustments in the activation process, pores of the required size for a particular purification application are developed.

Activated carbon removes organic compounds from liquids and gases by a process known as "adsorption." In adsorption, organic molecules contained in a liquid or gas are adhered (or stuck) to the surface of the pores of the activated carbon as the mist or gas is passed through. During adsorption, liquids or gases pass through a bed or layer of highly porous material called the adsorbent. Adsorption occurs on the internal surfaces of the materials. (Think sticky tape.) (Adsorption is not to be confused with absorption which is like the sponge that sucks up the pesticide spill.)

➤ **What is a gas mask?**

A gas mask is a full face-piece respirator with a canister. A full face-piece respirator with a cartridge is not a gas mask.



Demonstrating his patented gas mask in this 1915 photograph, **Garrett A. Morgan**, along with his brother, became heroes when they used them on July 25, 1916 to rescue several men overcome in the aftermath of the west side waterworks tunnel explosion.
Creator: Cleveland State University Michael Schwartz Library.



Gas Mask History

WWI French Duckbill gas mask filled with urine soaked rags to counteract Chlorine Gas attacks



Photo: Rusty Canteen Images

What was the source of an early version of activated charcoal in World War I?



Peach Pits

Photo: National Archives

Gas Mask History

WWI gas mask

A modified version of the British design, a canvas mask attached to a fiber hose with a charcoal filter attached. The charcoal was made from fruit pits and nut shells, both of which were often acquired from recruiting drives from the home front. The soldier had to breathe directly through the tube, as the canvas mask was not air tight like the later rubber masks.
Photo: Indiana War Memorial Museum

Is there one filter/cartridge that's good for all contaminants?

First responders have CBRN canisters available to them which are capable of filtering out chemical, biological, radiological and nuclear agents. These can also be used for other industrial chemicals (including pesticides such as phosphine, chloropicrin and sulfur dioxide). These tend to be expensive and carry expiration dates. Certain gas masks may accept canisters made by another company. This allows for sharing of canister supplies during an event when departments use different face masks. These have NIOSH approvals to allow this to occur.

Is sulfur dioxide an organic vapor?

No, sulfur dioxide (SO₂) does not contain any carbon, therefore it is not an organic vapor. The cartridge or canister to be used must specify "Sulfur Dioxide- SD" which usually is an "Acid Gas" cartridge.

What about "multi-gas" cartridges? Can these be used in situations where there are many types of gas in one area?







No. These cartridges are designed to simplify cartridge selection. For example, there are 2 different enclosed spaces, each with a different gas- organic vapor in one, and sulfur dioxide in the other. Rather than thinking about which cartridge to select, a multi-gas cartridge would work for entering either area. You could not use it to enter an enclosed space containing BOTH organic vapor AND sulfur dioxide. NIOSH approves the multi-gas cartridge for exposure to one gas at a time.

What is the difference between a cartridge and a canister?

The difference in a cartridge and canister is the approval process. If the filtering element is a cartridge, it has a respirator approval of 23C or 84A. If the filtering element is a canister it has a respirator approval of 14G. A canister can be used for escape from Immediately Dangerous to Life and Health (IDLH) atmospheres. Cartridges cannot be used for escape from IDLH. Cartridges and canisters are color coded according to which air contaminant they protect against.



Respirator cartridge color chart:

Listing of color codes for respirator cartridges that can be used in pesticide applications		
Color Code	Color	Protects Against
	Black	Organic vapors and paint spraying (except isocyanate containing paint)
	Green	Ammonia: anhydrous or from livestock confinement
	Yellow	Combination acid gases and organic vapor
	White	Acid gases
	Olive	Organic vapors, ammonia, acid gases and multiple gases
	Magenta	Dust and welding fumes

How long do the cartridges or canisters last?

It varies depending on the concentration of the chemicals, concentration of particulates, air flow, temperature and humidity. But, since you are not monitoring the air to determine these things, see the following for when to change the cartridges or canisters.

When do I have to change the cartridges or canisters? (Per the Worker Protection Standard)

- At the first indication of odor, taste, or irritation.
- When the maximum use time is reached as determined by a change schedule conforming to the provisions of 29 CFR 1910.134(d)(3)(iii)(B)(2). (Change schedule is based on concentrations and ambient air conditions. The Respirator Manufacturer can assist in determining.)
- When breathing resistance becomes excessive.
- When required according to manufacturer's recommendations or pesticide labeling instructions, whichever is more frequent.
- In the absence of any other instruction or indications of service life, at the end of eight hours of cumulative use.

National Occupational Safety & Health (NIOSH) is a branch of the Centers for Disease Control (CDC). Their National Personal Protective Testing Laboratory is tasked with Testing and Certifying (source of the "TC" approval number) respiratory protection. The approval is based on the filtering mechanism and attached face-piece. All pesticide products require that the respirators used be NIOSH approved.

Can I use a respirator when working with pesticides that is NOT NIOSH approved?

No.



The filtering medium in this Russian canister is ASBESTOS (photo credit en.wikipedia.org)

Can I put parts from one brand onto another brand of respirator?

Absolutely not. A respirator with all it's associated parts are what NIOSH approves. Combining parts from one respirator manufacturer on to another manufacturer's respirator, or adding anything else (like dryer tubing below) voids the NIOSH approval. Using anything that is not part of that initial assembly puts the respirator into a non-approved configuration.



Photo: Garnet Cooke

Dryer tube attached to cartridges is no longer NIOSH approved

In 1995 NIOSH revised their certification standards and language changed:

Where did the dust/mist respirator go?

It is now called a particulate respirator. Particulate refers to the type of filter, and can be either a filtering face piece respirator or a tight fitting elastomeric respirator with particulate filters.

Why do a particulate respirator and an organic vapor respirator with particulate filter have the same NIOSH Approval number (TC-84A)?

It is based on the *particulate* association. With the exception of PAPRs, if the filter is strictly for particulates, *or* has a cartridge with a particulate filter attached to it (combination), then it is all lumped under the "TC- 84A" designation. Pesticide labels requiring OV cartridges will normally require a combination filter for particulates.

Where do I find the NIOSH approval?

The NIOSH approval can be found on the filtering mechanism itself, such as a particulate filter, particulate filtering face piece respirator, cartridge or canister. It will also be on the approval packaging on the user instructions. The NIOSH approval consists of a code in the format "TC-XXX-XXXX", such as TC-84A, and will be stamped NIOSH.



3M St. Paul, Minnesota 1-800-243-4633 8293 Respirator		
THIS RESPIRATOR IS APPROVED FOR USE AS:		
RESPIRATOR COMPONENT		
FILTERING FACEPIECE		
TC-	PROTECTION [†]	8293
84A-2561	P100	X

Package insert

General Questions:

How can I tell which respirators are “disposable”?

The respirator packaging will state the word disposable. For half-face cartridge respirator, the key will be that the cartridges cannot be removed.

What is the difference between a filtering face piece and a half-face elastomeric respirator?

A filtering face piece consists entirely of the filtering material, and is disposable. When required by the pesticide label, it must be equipped with a sealable surface to ensure it can be fit tested. An elastomeric respirator is made of pliable silicone or latex material so that it can be fitted tightly against the face. These are designed with a reusable face-piece with changeable filters/cartridges (with proper cleaning in between.)



TC-84A

Filtering face-piece



TC-84A

Half-face elastomeric

What is the difference between loose fitting and tight fitting respirators?

A loose-fitting respirator does not depend on a tight seal with the face to provide protection. A loose fitting respirator does not need to be fit-tested. A tight-fitting respirator needs a tight seal with the face and or neck to provide protection. Anything that interferes with the seal is not permitted. A tight fitting respirator **MUST** be fit-tested annually. A loose fitting powered air purifying respirator (PAPR) does not.



TC-21C

Loose fitting respirator



TC-84A

Tight fitting particulate respirator

Can I use a half-face respirator for fumigants?

No. A full-face respirator must be used when respiratory protection is required by fumigant labels. Fumigants are irritants which affect the eyes and goggles are prohibited because the “indirect vents” will allow the gas to enter and be trapped against the eyes.

➤ **HOW TO DECODE:**

Below are two examples of label language one can readily find on pesticide labels. One is for particulate protection, the second for organic vapor. Both denote no oil is used in the application mix (pesticides or added adjuvants). In the label language, the outdated language will be **bolded**. Proceed to the table that follows for the key to the new language.

Respirator language:

FOR PARTICULATES:

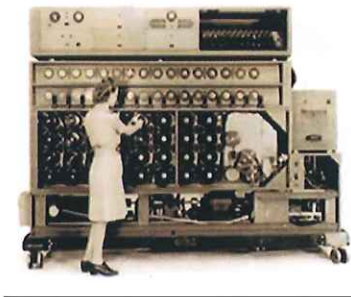
“For handling activities, use a **dust/mist filtering respirator** MSHA/NIOSH approval number prefix TC-21C); OR a NIOSH approved respirator with any N, R, P or HE filter”

FOR ORGANIC VAPOR: “...respirator with an organic-vapor removing cartridge with a **pre-filter** approved for pesticides (MSHA/NIOSH approval number prefix TC-23C), OR a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G OR a NIOSH approved respirator with an organic vapor (OV) cartridge or canister with any N, R, P or HE filter.”

➤ **DECODE:**

Translation KEY to the revised 1995 NIOSH certification standards and language changes:

Outdated EPA (NIOSH) language		Current NIOSH language
NIOSH/MSHA	➔	NIOSH
Dust/Mist	➔	Particulate
Pre-filter approved for pesticides	➔	Combination filter N, R or P
Canister approved for pesticides	➔	Canister (protects against chemical of concern.)
N, R, P or HE filters	➔	N, R or P (HE filters can only go on PAPRs.)



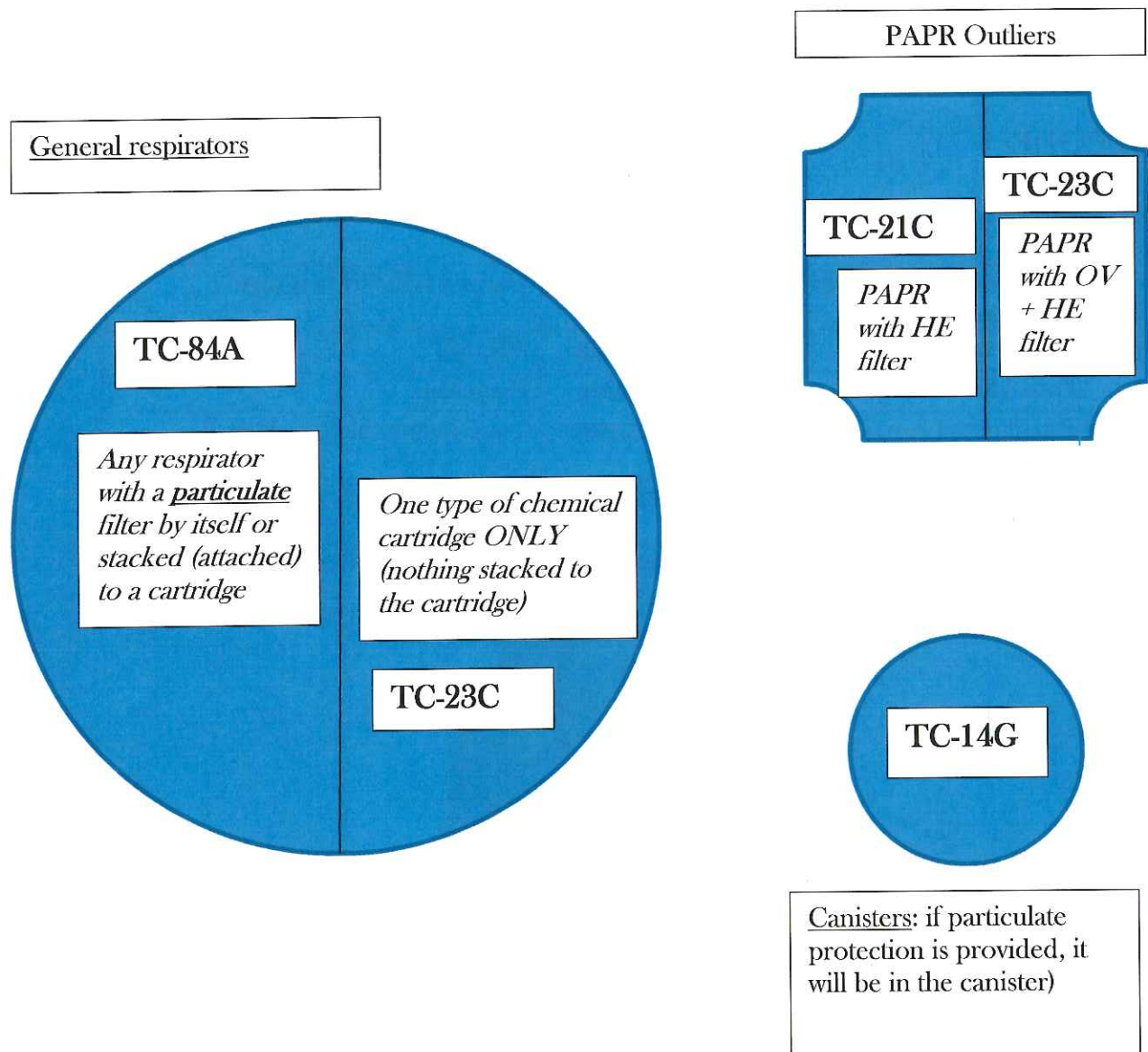
Here is Mabel hard at work on the Respirator Decoder

✓ Decoded:

FOR PARTICULATES: A NIOSH approved particulate respirator with any N, R or P filter with NIOSH approval number prefix TC-84A; or a NIOSH approved powered air purifying respirator with HE filter with NIOSH approval number prefix TC-21C.

FOR ORGANIC VAPOR:

A NIOSH-approved respirator with an organic vapor (OV) cartridge with a combination N, R, or P filter with NIOSH approval number prefix TC-84A; OR NIOSH approved gas mask with an organic vapor canister with NIOSH approval number prefix TC-14G; OR a NIOSH approved powered air purifying respirator with organic vapor (OV) cartridge and combination HE filter with NIOSH approval number prefix TC-23C.



✓ *Make a list of the types of respirators required by the pesticides you use.*

Pesticide Product & EPA Reg. #	Respirator statement calls for: Dust/Mist OR N, R, or P (Actually: Particulate)	Respirator statement calls for: OV + pre-filter approved for pesticides; OR OV + N, R or P filter	Respirator statement calls for: Gas Mask With canister approved for pesticides, OR canister for organic vapor, or phosphine (TC-14G)



Why not focus on the TC numbers for the 2nd and 3rd columns?

Because they BOTH are TC-84!

?

Can I use a MORE protective mask then the label says?
Yes, but never less.

If my chart tells me I need two types of respirators, particulate ONLY and OV + particulate, can I use OV + particulate for BOTH to be less confusing?
YES.

Pre 1995 NIOSH Language

Oil in Application Mix: "...respirator with an organic-vapor removing cartridge with a pre-filter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C), **OR** a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G **OR** a NIOSH approved respirator with an organic vapor (OV) cartridge **OR** canister with any R, P or HE filter.

Decrypted with Current NIOSH Language

Oil in Application Mix:

A NIOSH-approved respirator with an organic vapor (OV) cartridge with a combination R or P filter, with NIOSH approval number prefix TC-84A; **OR** NIOSH approved gas mask with an organic vapor canister with NIOSH approval number prefix TC-14G; **OR** a NIOSH approved powered air purifying respirator with organic vapor (OV) cartridge and combination HE filter, with NIOSH approval number prefix TC-23C.



No Oil in Application Mix:

"...respirator with an organic-vapor removing cartridge with a pre-filter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C), **OR** a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G **OR** a NIOSH approved respirator with an organic vapor (OV) cartridge or canister with any N, R, P or HE filter.

No Oil in Application Mix:

A NIOSH-approved respirator with an organic vapor (OV) cartridge with a combination N, R, or P filter with NIOSH approval number prefix TC-84A; **OR** NIOSH approved gas mask with an organic vapor canister with NIOSH approval number prefix TC-14G; **OR** a NIOSH approved powered air purifying respirator with organic vapor (OV) cartridge and combination HE filter with NIOSH approval number prefix TC-23C.



Pre 1995 NIOSH Language

Decrypted with Current NIOSH Language

Oil in Application Mix:

“For handling activities, use a dust/mist filtering respirator (MSHA/NIOSH approval number prefix TC-21C); **OR** a NIOSH approved respirator with any R, P or HE filter”

Oil in Application Mix:

A NIOSH approved particulate respirator with any R or P filter with NIOSH approval number prefix TC-84A; or a NIOSH approved powered air purifying respirator with HE filter with NIOSH approval number prefix TC-21C.



No oil in Application Mix:

“For handling activities, use a dust/mist filtering respirator MSHA/NIOSH approval number prefix TC-21C); **OR** a NIOSH approved respirator with any N, R, P or HE filter”

No oil in Application Mix:

A NIOSH approved particulate respirator with any N, R or P filter with NIOSH approval number prefix TC-84A; or a NIOSH approved powered air purifying respirator with HE filter with NIOSH approval number prefix TC-21C.



Below IDLH levels:

Phosphine: a NIOSH approved full face respirator with canister approved for chemical of concern with NIOSH approval number prefix TC-14G.

Sulfur dioxide: a NIOSH approved full face respirator with either an acid gas cartridge or a combination acid gas/organic vapor cartridge, NIOSH approval number prefix TC-23C.



TC-14G



**ACID GAS
CARTRIDGE 7200**



**ORGANIC
VAPOR/ACID GAS
CARTRIDGE 7300**

**Full face respirator with
Phosphine canister**



Why COMPONENTS Matter: NIOSH APPROVAL TC-84A



Filtering facepiece P 100



Elastomeric half face P100



Elastomeric half face N-95



Elastomeric half face OV +N95



Elastomeric half- face OV + N95



Full face OV + P100

Recap: NIOSH APPROVAL TC-23C



PAPR OV+HE



Full face OV ONLY



Half face OV or, Multi OV/Acid Gas

Levels of Protection -decreasing from top to bottom



SCBA, Air supplying,
NIOSH Approval: TC-13F
Most protective



Supplied Air Respirator
NIOSH Approval: TC-19C



Air Purifying
Full-face respirator with Canister
NIOSH Approval: TC-14G



Air Purifying
Full-face respirator with OV
cartridge + combination N-filter
NIOSH Approval: TC-84A



Powered Air Purifying
Respirator (PAPR)
OV + HE filters
NIOSH Approval: TC-23C



Powered Air Purifying
Respirator (PAPR)
Particulate HE filters
NIOSH Approval: TC-21C



Air purifying half-face elastomeric respirator
with OV cartridge + combination N filter
NIOSH Approval: TC-84A



Air purifying half-face elastomeric respirator with
particulate P-100 (magenta) or N filters (white)
NIOSH Approval: TC-84A



Particulate filtering face-piece respirator P-100
NIOSH Approval: TC-84A