Key Elements of a
Sound Respiratory Protection Program

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Because every life has a ***purpose...***

Contents

The fundamental goal of any respiratory protection program is to control occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, and/or vapors. The defense against these contaminants is simple: Keep them out of the air that workers breathe. Always implement engineering and/or administrative controls first. If contaminants still present a hazard, you must provide appropriate respiratory protection for every employee who might be exposed to them.

MSA can help you take a comprehensive approach to sound Respiratory Protection practices. This guide will help you understand the need for respirators, how they work, and what their limitations are.

OSHA (the Occupational Safety and Health Administration) and NIOSH (the National Institute of Occupational Safety and Health) regulations define all the specific requirements which must be followed, including the capabilities of appropriate respiratory protection. Employers must follow the requirements of these governmental regulations, both the general regulations which apply to all workplaces and the specific regulations for exposures in their particular industry, such as lead, silica dust, asbestos, and ammonia.

PremAire® Cadet Escape Respirator shown here

The 7 Key Elements

Chances are that you are already familiar with the need for and use of respirators in your workplace, but as with anything else, it doesn't hurt to review your current program against standard operating procedures governing the selection and use of respirators.

According to program details in OSHA's Respiratory Protection Standard (29 CFR 1910.134), the seven key elements that every respiratory protection program should contain are:

1. A written plan detailing how the program will be administered
2. A complete assessment and knowledge of respiratory hazards that will be encountered in the workplace
3. Procedures and equipment to control respiratory hazards, including the use of engineering controls and work practices designed to limit or reduce employee exposures to such hazards
4. Guidelines for the proper selection of appropriate respiratory protective equipment
5. An employee training program covering hazard recognition, the dangers associated with respiratory hazards, and proper care and use of respiratory protective equipment
6. Inspection, maintenance, and repair of respiratory protective equipment
7. Medical surveillance of employees

1 A Written Respiratory Protection Program

Administration

The first step in a respiratory protection program is to establish written standard operating procedures governing the selection and use of respirators. Regular inspection and evaluation of the program will ensure its continued effectiveness.

According to OSHA, a written program will help employers, employees, and compliance officers gauge the adequacy of a given program. When developing your written respiratory protection program, be sure to include the following elements, designated by 29 CFR Part 1910.134:

- Procedures for selecting respirators for use in the workplace
- Fit-testing procedures for tight-fitting respirators (including a signed copy of employees' fit-test records)
- Procedures for proper use of respirators in routine and emergency situations
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, and repairing respirators
- Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators
- Medical evaluations of employees required to wear respirators

Employers must:

- Submit a written respiratory protection program unless the choice of voluntary respiratory protection is a filtering facepiece (dust mask)
- Provide voluntary respirator users with Appendix D of the Standard
- Ensure that employees using a respirator voluntarily have medical clearance

Employees must clean, store, and maintain the respirator so that its use does not present a health hazard.

If possible, one person should administer these procedures, to ensure consistent coordination and direction and optimum results. The actual respiratory protection program itself for each workplace depends upon many factors, and may require input from specialists such as safety personnel, industrial hygienists, health physicists and physicians.

Voluntary Respirator Use

An employer must provide respiratory protection for employees who ask for it or let employees use their own respiratory protection, if such respirator use will not create a hazard. Fit testing is not required for voluntary use.

Respiratory Hazards

Before a respiratory protection program is initiated, it is important to first understand the types of respiratory hazards inherent to your industry. Of the three normally recognized ways toxic materials can enter the body—through the (1) gastrointestinal tract, (2) skin, and (3) lungs—the respiratory system presents the quickest and most direct avenue of entry. This is because of the respiratory system's direct relationship with the circulatory system and the constant need to oxygenate tissue cells to sustain life.

The three basic classifications of respiratory hazards are:

- oxygen-deficient air
- particulate contaminants
- gas and vapor contaminants

Oxygen Deficiency

Normal ambient air contains an oxygen concentration of 20.8% by volume. When the oxygen level dips below 19.5%, the air is considered oxygen-deficient. Oxygen concentrations below 16% are considered unsafe for human exposure because of harmful effects on bodily functions, mental processes, and coordination.

It is important to note that life-supporting oxygen can be further displaced by other gases, such as carbon dioxide. When this occurs, the result is often an atmosphere that can be dangerous or fatal when inhaled. Oxygen deficiency also can be caused by rust, corrosion, fermentation, or other forms of oxidation which consume oxygen. The impact of oxygen-deficiency can be gradual or sudden.

Particulate Contaminants

Particulate contaminants can be classified according to their physical and chemical characteristics and their physiological effect on the body. The particle diameter in microns (1 micron = 1/25,400 inch) is of utmost importance. Particulates below 10 microns in diameter have a greater chance to enter the respiratory system, and particles below 5 microns in diameter are more apt to reach the deep lung or alveolar spaces.

In healthy lungs, particles from 5 to 10 microns in diameter are generally removed from the respiratory system by a constant cleansing action that takes place in the upper respiratory tract. However, with excessive "dust" exposures or a diseased respiratory system, the efficiency of the cleansing action can be significantly reduced.

The various types of airborne particulate contaminants can be classified as follows:

Fumes—An aerosol created when solid material is vaporized at high temperatures and then cooled. As it cools, it condenses into extremely small particles—generally less than 1 micron in diameter. Fumes can result from operations such as welding, cutting, smelting, or casting molten metals.

Dusts—An aerosol consisting of mechanically produced solid particles derived from the breaking up of larger particles. Dusts generally have a larger particle size when compared to fumes. Operations such as sanding, grinding, crushing, drilling, machining, or sand blasting are the worst dust producers. Dust particles are often found in the harmful size range of 0.5 to 10 microns.

Mists—An aerosol formed by liquids, which are atomized and/or condensed. Mists can be created by such operations as spraying, plating, or boiling, and by mixing or cleaning jobs. Particles are usually in the size range of 5 to 100 microns.

Gas and Vapor Contaminants

Gas and vapor contaminants can be classified according to their chemical characteristics.

True gaseous contaminants are similar to air in that they possess the same ability to diffuse freely within an area or container. Nitrogen, chlorine, carbon monoxide, carbon dioxide, and sulfur dioxide are examples.

In terms of chemical characteristics, gaseous contaminants may be classified as follows:

Inert Gases—These include such true gases as helium, argon, neon, etc. Although they do not metabolize in the body, these gases represent a hazard, because they can produce an oxygen deficiency by displacement of air.

Acidic Gases—Often highly toxic, acidic gases exist as acids or produce acids by reaction with water. Sulfur dioxide, hydrogen sulfide and hydrogen chloride are examples.

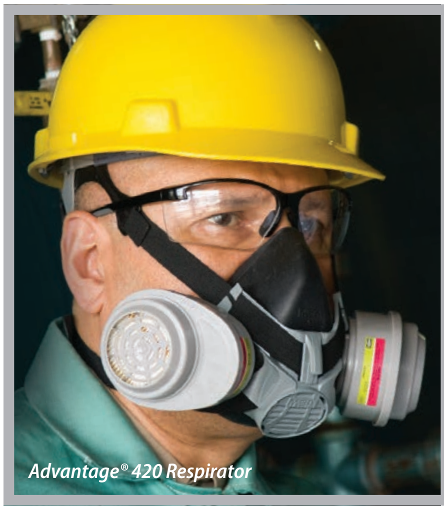
Alkaline Gases—These gases exist as alkalis or produce alkalis by reaction with water. Ammonia and phosphine are two examples.

Vapors are the gaseous state of substances that are liquids or solids at room temperature. They are formed when the solid or liquid evaporates.

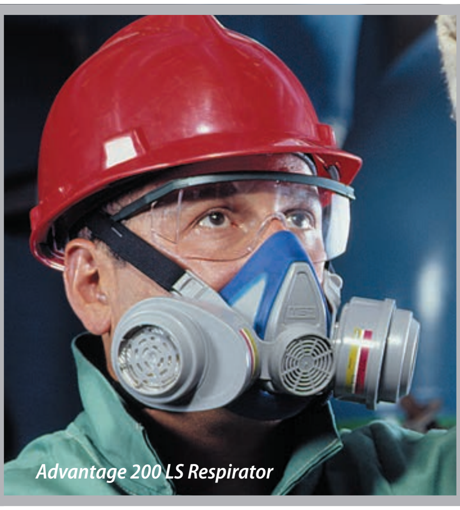
In terms of chemical characteristics, vaporous contaminants may be classified as follows:

Organic Compounds—Contaminants in this category can exist as true gases or vapors produced from organic liquids. Gasoline, solvents, and paint thinners are examples.

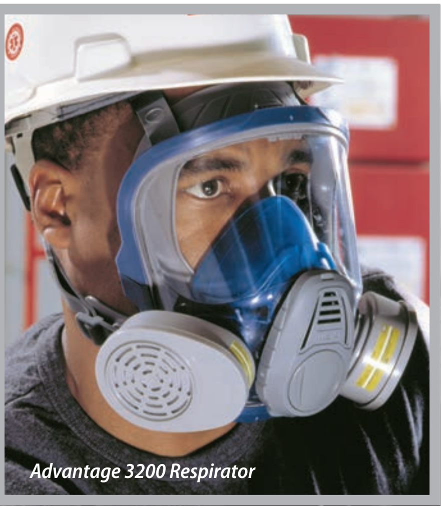
Organometallic Compounds—These are generally comprised of metals attached to organic groups. Tetraethyllead and organic phosphates are examples.



Advantage® 420 Respirator



Advantage 200 LS Respirator



Advantage 3200 Respirator

2 Hazard Assessment

Proper assessment of your specific hazard(s) is the first important step to protection. This requires a thorough knowledge of processes, equipment, raw materials, end-products, and by-products that can create an exposure hazard. First, you must make an initial determination of workplace conditions. This simple calculation of exposures does not require sampling of the environment. Factor in workplace size, ventilation, the amount of the regulated substance present, the type of operation, and the proximity of the workers to the source of emissions.

According to OSHA, personal exposure monitoring is the "gold standard" for determining employee exposure. It is the most reliable approach for assessing the level and type of respiratory protection required. Sampling which uses methods appropriate for contaminants(s) should represent the worst-case exposures or enough shifts and operations to determine the accurate range(s) of exposure.

To determine an atmosphere's oxygen content or concentration levels of particulate and/or gaseous contaminants, air samples must be taken with proper sampling instruments during all conditions of operation. The sampling device and the type and frequency of sampling (spot testing or continuous monitoring) will be dictated by the exposure and operating conditions.

Breathing zone samples are recommended and sampling frequency should be sufficient to assess the average exposure under the variable operating and exposure conditions.

Should contaminant concentrations exceed exposure limits recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), OSHA, or NIOSH, hazard control procedures must be implemented promptly.

The employer is required to evaluate respiratory hazards in the workplace, identify relevant workplace and use factors, and base respirator selection on these factors.

Exposure Monitoring

Exposure monitoring plays a critical role in the respirator selection process. The results from such testing will help you determine whether respiratory protection is needed and, if it is, the type of respirator that is required. Generally, respirator selection is based on three factors:

- The results of your atmospheric monitoring or sampling program
- The accepted ACGIH, OSHA, or NIOSH exposure limits for the substance(s) present
- The maximum use concentration (of a substance) for which a respirator can be used

3 Hazard Control

Hazard control should start at the process, equipment, and plant design levels where contaminants can be controlled effectively at the outset. With operating processes, the problem becomes more difficult. In all cases, however, attention should be given to the use of effective engineering controls to eliminate and/or reduce exposures to respiratory hazards. This includes consideration of process encapsulation or isolation; use of less toxic materials in the process' and suitable exhaust ventilation, filters, and scrubbers to control the effluents.

Because it is sometimes not practical to maintain engineering controls that eliminate all airborne concentrations of contaminants, proper respiratory protective devices should be used whenever such protection is required.


AirHawk® MMR SCBA


G1 PremAire Cadet Escape Respirator System


OptimAir® TL Powered Air-Purifying Respirator

OSHA's Assigned Protection Factors Table

TYPE OF RESPIRATOR[1, 2]	Quarter mask	Half mask	Full facepiece	Helmet/ hood	Loose-fitting facepiece
1. Air-Purifying Respirator	5	[3]10	50		
2. Powered Air-Purifying Respirator (PAPR)		50	1000	[4]25/1,000	25
3. Supplied-Air Respirator (SAR) or Airline Respirator • Demand mode • Continuous flow mode • Pressure-demand or other positive-pressure mode		10 50 50	50 1,000 1,000	[4]25/1,000	25
4. Self-Contained Breathing Apparatus (SCBA) • Demand mode • Pressure-demand or other positive-pressure mode (e.g., open/closed circuit)		10	50 10,000	50 10,000	

Notes:

[1] Employers may select respirators assigned for use in higher workplace concentrations of a hazardous substance for use at lower concentrations of that substance, or when required respirator use is independent of concentration.

[2] The assigned protection factors in Table 1 are only effective when the employer implements a continuing, effective respirator program as required by this section (29 CFR 1910.134), including training, fit testing, maintenance, and use requirements.

[3] This APF category includes filtering facepieces, and half masks with elastomeric facepieces.

[4] The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1,000. This level of performance can best be demonstrated by performing a WPF or SWPF study or equivalent testing. Absent such testing, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

[5] These APFs do not apply to respirators used solely for escape. For escape respirators used in association with specific substances covered by 29 CFR 1910 subpart Z, employers must refer to the appropriate substance-specific standards in that subpart. Escape respirators for other IDLH atmospheres are specified by 29 CFR 1910.134 (d)(2)(ii).

4 Respirator Selection

All respirators in use must be NIOSH-approved (NIOSH 42 CFR Part 84). Selecting respirators entails knowing what level of respiratory protection employees need, as well as which size respirator is right for any face and facial contours.

Respiratory protective devices vary in design, application, and protective capability. Thus, the user must assess the inhalation hazard and understand the specific use limitations of available equipment to assure proper selection.

If your calculation shows that exposure concentrations exceed recommended limits and engineering/administrative controls do not reduce exposure below the permissible limit, tailor your respiratory protection program to your specific conditions based on:

- Toxicity (TLV or TWA)
- Maximum Expected Concentration
- OSHA assigned protection factors
- Oxygen level
- IDLH concentration
- Warning properties (adequate or not)
- Sorbent limitations
- Facepiece fit
- Mobility requirements
- Type of use (routine, escape, or emergency entry)

Types of Respirators

Respirators fall under two classifications: **air-purifying** and **air-supplied**. Air-purifying respirators are used against particulates, gases, and vapors. These are categorized as negative-pressure respirators that use chemical cartridges and/or filters; gas masks; and positive-pressure units such as powered air-purifying respirators (PAPRs). Air-supplied devices rely on a primary air source to deliver a steady flow of respirable air to the user's facepiece. These consist of Self-Contained Breathing Apparatus (SCBA) and air-line devices.

Air-Purifying Respirators (APRs) range from simple disposable cup masks to low-maintenance half-mask facepieces with cartridges and/or filters to the more complex PAPRs with full- facepieces or hoods.

- **APRs for particulates** use filters to capture dusts, mists, and fumes. Filters do not protect against gases or vapors, and generally become less effective as particles accumulate on the filter and plug spaces between the fibers. Some filtering APRs require filter replacement when the user finds it difficult to breathe through them. Others should be changed after each shift.
- **Gas and vapor APRs** employ chemical cartridges or canisters to remove hazardous gases or vapors from the air. They do not protect against airborne particles. Made to protect against specific gases or vapors, they provide protection only as long as the cartridge's absorbing capacity is not depleted.

The service life of a chemical cartridge depends upon many factors and can be estimated in various ways. Cartridges and canisters require an end-of-service-life indicator (ESLI) or a change schedule, based on objective information or data that will ensure that canisters and cartridges are changed before the end of their useful life. In the respirator program, the employer must describe the information and data relied upon and the basis for the canister and cartridge change schedule as well as the basis for reliance on the data.

- **Combination APRs**, fitted with both particulate filters and gas/vapor cartridges, are worn in atmospheres that contain hazards of both particulates and gases. **Supplied-Air Respirators (SARs)**, comprise air-line respirators, SCBA, and combination (supplied-air) respirators.
- **Air-Line Respirators** are used for extended periods in non-IDLH atmospheres. They use an air-line hose to deliver clean breathing air from a stationary source of compressed air for prolonged periods of time. Although comparatively lightweight, air-line respirators can limit users' mobility because of the air-line hose that must be attached.
- **Self-Contained Breathing Apparatus (SCBA)** have an open-circuit design that provides air rated for 30 to 60 minutes. They consist of a wearable, clean-air supply and a tight-fitting facepiece, and are used for short-duration entrance or escape from atmospheres that are or may be IDLH. They offer relatively unrestricted movement.
- **Combination SARs** are air-line devices used for extended work periods in atmospheres that are or may be IDLH. They have an auxiliary self-contained air cylinder that can be used if the primary air supply fails. The air cylinder can also be used for entry into or escape from IDLH atmospheres, such as confined spaces.

Employers are required to provide employees using SARs with breathing gases of high purity, and ensure that compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration is in accordance with the specifications of OSHA Standard 1910.134(i).

5 Training

For proper use of any respiratory protection device, it is essential that the user be properly instructed in its selection, use, and maintenance. Both supervisors and workers must be so instructed by competent persons.

Minimum training must include:

- Methods of recognizing respiratory hazards
- Instruction in the hazards and an honest appraisal of what could happen if the proper respiratory protection device is not used
- Explanation of why more positive control is not immediately feasible. This must include recognition that every reasonable effort is first being made to reduce or eliminate the need for respiratory protection
- A discussion of why various types of respiratory protection devices are suitable for particular purposes
- A discussion of the device's capabilities and limitations
- Instruction and training in actual use of respiratory protection equipment, and definite and frequent supervision to assure that it continues to be properly used
- Classroom and field training to recognize and cope with emergency situations

Before an employee may be required to use any respirator with a negative- or positive-pressure tight-fitting facepiece, the employee must be fit tested with the same make, model, style, and size of respirator that will be used.

Training should provide personnel with an opportunity to handle the device, have it fitted properly, test its face-to-facepiece seal, wear it in normal air for a long familiarity period, and, finally, wear it in a test atmosphere. OSHA requires fit tests to ensure proper fit for workers who use respirators.

Fit Testing

OSHA requires fit testing for any face mask (full or half) designed to have a tight seal along the face, whether it is used in a positive- or negative-pressure mode, and whether it is disposable or not.

Qualitative fit test methods are subjective in nature and rely on the judgment of the test subject. They are essentially a pass/fail fit test to assess the adequacy of respirator fit.

Quantitative testing methods rely on objective data to determine a proper fit. An assessment of the adequacy of respirator fit is determined by numerically measuring the amount of leakage into the respirator.

If the required fit factor is greater than 100, i.e., when higher levels of respiratory protection are needed, quantitative fit-testing must be conducted. Most experts agree that quantitative fit-testing provides the most accurate information, because it uses actual test data, rather than depending on the respirator wearer's sense of smell and taste (subjective responses).

OSHA requires these eight exercises for both qualitative and quantitative fit testing:

1. normal breathing
2. deep breathing
3. head side to side
4. head up and down
5. talking out loud
6. grimacing (quantitative only)
7. bending
8. normal breathing

6 Respirator Care

Proper inspection, maintenance, and repair of respiratory protective equipment are mandatory to ensure success of any respiratory protection program. The goal is to maintain the equipment in a condition that provides the same effectiveness as it had when it was first manufactured.

All equipment must be inspected before and after each use. A record of all inspections by date must be kept, with the results tabulated. It is important to follow the recommendations of the manufacturer precisely.

All non-disposable respiratory protective equipment must be cleaned and decontaminated after each use. Disposable respirators and accessories should be discarded after each use, and replaced with identical new respirators.

Replacement of other than disposable parts must be done only by personnel with adequate training to ensure that the equipment is functioning properly after the work is accomplished. Only parts supplied by the manufacturer for the product being repaired must be used.

7 Medical Surveillance

According to OSHA, "using a respirator may place a physiological burden on employees that varies with the type of respirator worn, the job and workplace conditions in which the respirator is used, and the medical status of the employee." Employers must determine an employee's ability to use a respirator.

Workers should never be assigned to any operation requiring respiratory protection until a physician has determined that they are capable—physically and psychologically—to perform the work using the respiratory protective equipment.

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Program Evaluation

Employers are required to conduct periodic evaluations of the workplace to ensure that the written respiratory protection program is being properly implemented, and to consult employees to ensure that they are using the respirators properly. The employer must regularly consult employees required to use respirators to assess the employees' views on program effectiveness and to identify any problems. Any problems that are identified during this assessment must be corrected.

Factors to be assessed include, but are not limited to:

- Respirator fit (including the ability to use the respirator without interfering with effective workplace performance)
- Appropriate respirator selection for the hazards to which the employee is exposed
- Proper respirator use under the workplace conditions the employee encounters
- Proper respirator maintenance

Important

This document is intended to help employers understand the respiratory protection requirements of OSHA and NIOSH government standards, and is not intended to be the sole guide for complying with 29 CFR Part 1920.134 (OSHA) and 42 CFR Part 84 (NIOSH).

These government documents may be found in their entirety at **www.osha.gov**

Record Keeping

Employers must retain written information regarding medical evaluations, fit testing, and the respirator program. This information will facilitate employee involvement in the respirator program, assist the employer in auditing the adequacy of the program, and provide a record for compliance determinations by OSHA.

Records must be kept on:

- Medical evaluation
- Qualitative and Quantitative Fit Tests, which are retained until the next fit test is administered
- Employee identity
- Make, model, style, and size of respirator tested
- Date of test
- Results
- Written copy of the current respirator program

Although instituting a sound respiratory protection program will take effort and financial investment, the objective of a such a program is sound—ensuring that every worker is protected against potentially fatal diseases.

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