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## Personal Protective Equipment



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**Title**

**Table of contents:**

Hazard assessment ..... 5

Training..... 5

Administrative controls (also called work practice controls) ..... 5

Engineering controls..... 6

Respiratory protection ..... 6

    What is a respirator? ..... 6

    Why do employees need respirators? ..... 6

    When do employees need to wear respirators? ..... 6

    How to ensure proper protection ..... 7

    How to develop an effective respiratory protection program ..... 7

    How to choose the correct respirator ..... 8

    What are specific respirator uses? ..... 10

    Who needs to be trained?..... 11

    How to make sure the respirators fit properly..... 11

    How to inspect and take care of respirators..... 12

    Are medical evaluations necessary? ..... 13

    How to monitor work areas..... 13

    What equipment and air quality standards apply? ..... 14

Head protection ..... 14

    Why do employees need head protection? ..... 15

    What common hazards will hard hats protect employees from?..... 15

    How can employees protect themselves? ..... 15

    Hard hat inspection and maintenance..... 15

    Hard hat routine replacement ..... 15

    Stickers on the hard hat..... 16

    Wearing a hard hat backwards ..... 16

Hand protection..... 16

    Employer responsibility ..... 16

    All gloves are not created equal ..... 16

Selecting a glove.....	17
Foot and leg protection.....	17
Protection from what?.....	18
What causes foot injuries?.....	18
Slips and falls.....	18
Punctures.....	18
Falling objects.....	18
Equipment.....	18
Safety shoes.....	18
Safety boots.....	19
Leggings and footguards.....	19
Overboots.....	19
Selecting foot protection.....	19
Hearing protection.....	20
Engineering controls.....	21
Administrative controls.....	21
Hearing protection devices.....	22
Noise reduction rating (NRR).....	22
Earmuffs.....	22
Earplugs.....	22
Hearing bands.....	22
Dual hearing protection.....	23
Audiometric testing.....	23
The bottom line—PPE saves lives.....	23
Related KellerOnline links.....	23

## Personal protective equipment

Personal protective equipment (PPE) is a broad category of lifesaving equipment that encompasses respiratory, head, hand, foot, and hearing protection.

OSHA has standards that regulate PPE. While these requirements have to be met to be in compliance, there are certain instances where knowing more than the regulation is necessary to protect employees.

This best practice looks at each general type of PPE and goes beyond the OSHA standards and discusses what works in the “real” world.

## Hazard assessment

Hazard assessment could be the subject of its own best practice. It's an important and complex subject that needs to be understood before providing employees with any type of protective equipment.

In order to determine if employees need to wear PPE, the employer must assess the workplace to determine if hazards are present, or are likely to be present.

If such hazards are present, or likely to be present, the employer has to:

- Select, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment;
- Communicate selection decisions to each affected employee; and
- Select PPE that properly fits each affected employee.

## Training

Employers must train all affected employees in the proper donning (putting on) and doffing (taking off) of PPE.

## Administrative controls (also called work practice controls)

Before even thinking about PPE as protection for workers, administrative controls should be considered. Administrative controls are changes in the work schedule or work procedures that reduce the duration, frequency, and severity of exposure to hazardous chemicals or situations. They involve removing the worker from the area or limiting the time workers are exposed to the hazard.

Administrative controls can always be used to control employee exposure. However, human error can affect the application of administrative controls; therefore they can not be relied upon to reduce exposure all the time.

For example, someone who is handling heavy engine parts can wear steel-toes boots to protect their feet, but nearby workers without foot protection will be exposed to the hazards. If you require that all workers at the facility wear foot protection, everyone will be protected. But if someone forgets to wear their steel-toed boots (human error) and an engine part falls on their foot they will be injured.

## Engineering controls

Engineering controls should also be considered before selecting PPE for employee protection. Engineering controls eliminate or reduce exposure to a hazardous chemical or a physical hazard through the use (or substitution of) some type of engineered machinery or equipment.

While PPE (like respirators) can help protect an individual from a hazardous material, engineering controls protect every worker by reducing or eliminating the hazard. For example, someone who is working in a paint booth can wear a respirator and avoid inhaling the toxic fumes. However, nearby workers without any respiratory protection will be exposed. But, if the employer installs proper local exhaust ventilation, then everyone will be protected.

Remember that administrative, engineering, and PPE are not mutually exclusive. Employers may need to use multiple types of controls to prevent employee overexposure.

## Respiratory protection

### What is a respirator?

A respirator is a protective device that covers the nose and mouth or the entire face or head to guard the wearer against hazardous atmospheres. Respirators may be:

- Tight-fitting—that is, half masks, which cover the mouth and nose, and full facepieces that cover the face from the hairline to below the chin; or
- Loose-fitting, such as hoods or helmets that cover the head completely.

In addition, there are two major classes of respirators:

- Air-purifying, which remove contaminants from the air; and
- Atmosphere-supplying, which provide clean, breathable air from an uncontaminated source.

As a general rule, atmosphere-supplying respirators are used for more hazardous exposures.

### Why do employees need respirators?

When employees must work in environments with insufficient oxygen or where harmful dusts, fogs, smokes, mists, fumes, gases, vapors, or sprays are present, they need respirators. These health hazards may cause cancer, lung impairment, other diseases, or death.

Where toxic substances are present in the workplace and engineering controls are inadequate to reduce or eliminate them, respirators are necessary. Some atmosphere-supplying respirators can also be used to protect against oxygen-deficient atmospheres. Increased breathing rates, accelerated heartbeat, and impaired thinking or coordination occur more quickly in an oxygen-deficient or other hazardous atmosphere. Even a momentary loss of coordination can be devastating if it occurs while a worker is performing a potentially dangerous activity such as climbing a ladder or operating a piece of machinery.

### When do employees need to wear respirators?

Employees need to wear respirators whenever administrative and engineering control measures (mentioned earlier) are not adequate to prevent atmospheric contamination at the worksite.

- Strategies for preventing atmospheric contamination may include:

- Enclosing or confining the contaminant-producing operation,
- Exhausting the contaminant, or
- Substituting with less toxic materials.

Respirators have their limitations and are not a substitute for effective engineering and administrative control measures. When it is not possible to use these controls to reduce airborne contaminants below their occupational exposure levels, such as during certain maintenance and repair operations, emergencies, or when engineering controls are being installed, respirator use may be the best or only way to reduce worker exposure.

### **How to ensure proper protection**

OSHA's respirator standard requires employers to establish and maintain an effective respiratory protection program when employees must wear respirators to protect against workplace hazards. Different hazards require different respirators, and employees are responsible for wearing the appropriate respirator and complying with the respiratory protection program.

The standard contains requirements for program administration, worksite-specific procedures, respirator selection, employee training, fit testing, medical evaluation, and respirator use, cleaning, maintenance, and repair.

Employees must use respirators while effective engineering controls, if they are feasible, are being installed. If engineering controls are not feasible, employers must provide respirators and employees must wear them when necessary to protect their health.

The employee's equipment must be properly selected, used, and maintained for a particular work environment and contaminant. In addition, employers must train employees in all aspects of the respiratory protection program.

### **How to develop an effective respiratory protection program**

The primary objective of the respiratory protection program is to prevent exposure to air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, vapors, or sprays, and thus to prevent occupational illness.

A program administrator must be responsible for the program. This person must know enough about respirators to supervise the program properly.

### **Large versus small companies**

Larger plants or companies with industrial hygiene, in-house medical department, safety engineering, or fire prevention departments should administer the program in

liaison with the program administrator. In smaller plants without specialists, an upper-level superintendent, foreman, or qualified person must serve as program administrator.

### **Training for all respirator users**

Any respirator program should stress thorough training of all respirator users. Employees must be aware that a respirator does not eliminate the hazard. If the respirator fails, the user will be overexposed to dangerous substances. To reduce the possibility of failure, the respirator must fit properly and be maintained in a clean and serviceable condition.

Employers and employees must understand the respirator's purpose and limitations. Users must not alter or remove the respirator even for a short time, even if it is uncomfortable.

## Respirator program

An effective respirator program must cover the following factors:

- Written worksite-specific procedures;
- Program evaluation;
- Selection of an appropriate respirator approved by the National Institute for Occupational Safety and Health (NIOSH);
- Training;
- Fit testing;
- Inspection, cleaning, maintenance, and storage;
- Medical evaluations;
- Work area surveillance; and
- Air quality standards.

Whenever OSHA standards or employers require respirator use, there must be a complete respiratory protection program. Employers must have written operating procedures to ensure that employees use the respirators safely and properly. Users must be familiar with these procedures and with the respirators available and their limitations.

In workplaces with no hazardous exposures, but where workers choose to use respirators voluntarily, certain written program elements may be necessary to prevent potential hazards associated with respirator use.

### Voluntary respirator use

Employers must evaluate whether respirator use itself may actually *harm* employees. If so, employers must medically evaluate employees and, if necessary, restrict respirator use, as well as comply with program elements. Employers must inform employees voluntarily using respirators of basic information in Appendix D of OSHA's respiratory protection standard.

### Evaluation of respirator use

Employers must evaluate the effectiveness of a company's respirator program regularly and modify the written operating procedure as necessary to reflect the evaluation results. A labor-management team may be effective in conducting these periodic evaluations.

## How to choose the correct respirator

Choosing the right equipment involves:

- Determining what the hazard is and its extent,
- Considering user factors that affect respirator performance and reliability, and
- Selecting an appropriate NIOSH-certified respirator.

Equipment must be used in line with specifications accompanying the NIOSH certification.

When selecting respirators, employers must consider the chemical and physical properties of the contaminant, as well as the toxicity and concentration of the hazardous material and the amount of

oxygen present. Other selection factors are nature and extent of the hazard, work rate, area to be covered, mobility, work requirements and conditions, as well as the limitations and characteristics of the available respirators.

### **Air-purifying respirators**

Air-purifying respirators use filters or sorbents to remove harmful substances from the air. They range from simple disposable masks to sophisticated devices. They do not supply oxygen and must not be used in oxygen-deficient atmospheres or in other atmospheres that are immediately dangerous to life or health (IDLH).

### **Atmosphere-supplying respirators**

Atmosphere-supplying respirators are designed to provide breathable air from a clean air source other than the surrounding contaminated work atmosphere. They include supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

### **Determining the type of respiratory protection**

The time needed to perform a given task, including the time necessary to enter and leave a contaminated area, is an important factor in determining the type of respiratory protection needed. For example, SCBAs, gas masks, or air-purifying chemical-cartridge respirators provide respiratory protection for relatively short periods. On the other hand, an atmosphere-supplying respirator that supplies breathable air from an air compressor through an air line can provide protection for extended periods.

If the total concentration of atmospheric particulates is low, particulate filter air-purifying respirators can provide protection for long periods without the need to replace the filter. Where there are higher concentrations of contaminants, however, an atmosphere-supplying respirator such as the positive-pressure SAR offers better protection for a longer period.

SARs eliminate the need for concern about filter breakthrough times, change schedules, or using end-of service-life indicators (ESLI) for airborne toxic materials,

factors that must be considered when using air-purifying respirators.

### **Performing the job safely**

Respirators must not impair the worker's ability to see, hear, communicate, and move as necessary to perform the job safely. For example, atmosphere-supplying respirators may restrict movement and present other potential hazards. SARs with their trailing hoses can limit the area the wearer can cover and may present a hazard if the hose comes into contact with machinery.

Similarly, a SCBA that includes a back-mounted, compressed-air cylinder is both large and heavy. This may restrict climbing and movement in tight places and the added weight of the air cylinder presents an additional burden to the wearer.

### **Air-supply rate**

Another factor to consider when using respirators is the air-supply rate. The wearer's work rate determines the volume of air breathed per minute. The volume of air supplied to meet the breathing requirements is very significant when using atmosphere-supplying respirators such as self-contained and airline respirators that use cylinders because this volume determines their operating life.

The peak airflow rate also is important in the use of a constant-flow SAR. The air-supply rate should always be greater than the maximum amount of air being inhaled in order to maintain the respiratory enclosure under positive pressure.

Higher breathing resistance of air-purifying respirators under conditions of heavy work may cause the user breathing difficulty, particularly in hot, humid conditions. To avoid placing additional stress on the wearer, use the lightest respirator possible that presents the least breathing resistance.

### Remaining service time

SCBAs and some chemical-canister respirators provide a warning of remaining service time. This may be a pressure gauge or timer with an audible alarm for SCBAs or a color ESLI on the cartridge or canister. The user should understand the operation and limitations of each type of warning device. For the many gas masks and chemical-cartridge respirators with no ESLI devices, the employer must establish and enforce a cartridge or canister change schedule. In addition, employees should begin each work shift with new canisters and cartridges.

### What are specific respirator uses?

The following list presents a simplified version of characteristics and factors used for respirator selection. It does not specify the contaminant concentrations or particle size.

The following table provides more detailed information on respirator selection:

Hazard	Respirator
<b>Immediately dangerous to life or health (IDLH)<sup>2</sup></b>	
<ul style="list-style-type: none"> <li>Oxygen deficiency</li> <li>Gas, vapor contaminants and other highly toxic air contaminants</li> </ul>	Full-facepiece, pressure-demand SCBA certified for a minimum service life of 30 minutes. A combination full-facepiece, pressure-demand SAR with an auxiliary self-contained air supply.
Contaminated atmospheres—for escape	Positive-pressure SCBA. Gas mask. Combination positive-pressure SAR with escape SCBA.
<b>Not immediately dangerous to life or health</b>	
Gas and vapor contaminants	<ul style="list-style-type: none"> <li>Positive-pressure SAR,</li> <li>Gas mask,</li> <li>Chemical-cartridge respirator, or</li> <li>Canister respirator.</li> </ul>
Particulate contaminants	<ul style="list-style-type: none"> <li>Positive-pressure SAR including abrasive blasting respirator,</li> <li>Powered air-purifying respirator equipped with high-efficiency filters, or</li> <li>Any air-purifying respirator with a specific particulate filter.</li> </ul>
Gaseous and particulate contaminants	Positive-pressure supplied respirator, Gas mask, or Chemical-cartridge respirator with mechanical filters.
Smoke and other fire-related contaminants	Positive-pressure SCBA.

<sup>2</sup> "Immediately dangerous to life or health" (IDLH) means an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

## Who needs to be trained?

Training is essential for correct respirator use. Employers must teach supervisors and workers how to properly select, use, and maintain respirators. All employees required to use respiratory protective equipment must receive instruction in

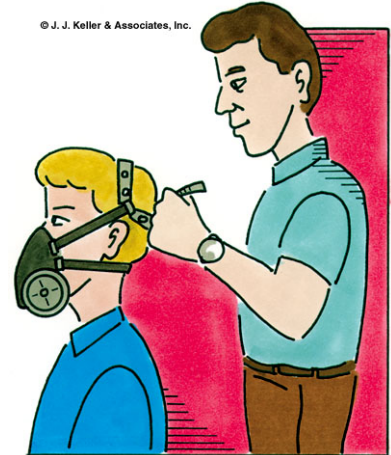
the proper use of the equipment and its limitations. Employers should develop training programs based on the employee's education level and language background.

Training must be comprehensive enough for the employee to:

- Demonstrate knowledge of the limitations and capabilities of the respirator;
- Why the respirator is necessary; and
- How improper fit, usage, or maintenance can compromise the respirator.

Training must include an explanation of the following:

- Why respirator use is necessary;
- Nature of the respiratory hazard and consequences of not fitting, using, and maintaining the respirator properly;
- Reason(s) for selecting a particular type of respirator;
- Capabilities and limitations of the selected respirator;
- How to inspect, put on and remove, and check the seals of the respirator;
- Respirator maintenance and storage requirements;
- How to use the respirator effectively in emergency situations, including when the respirator malfunctions; and
- How to recognize medical signs and symptoms that may limit or prevent the effective use of the respirator.



Users should know that improper respirator use or maintenance may cause overexposure. They also should understand that continued use of poorly fitted and maintained respirators can cause chronic disease or death from overexposure to air contaminants.

## How to make sure the respirators fit properly

Different types of respirators and even different brands of the same type of respirator have different fit characteristics. No one respirator will fit everyone. Some employees may be unable to get an adequate fit with certain respirator models of a particular type of respirator. This is why employers must provide a sufficient number of respirator models and sizes to ensure that every employee can select an acceptable respirator that fits properly.

## Eyeglasses may be a problem

Corrective eyeglasses worn by employees also present a problem when fitting respirators. Special mountings are available to hold corrective lenses inside full facepieces. A qualified individual must fit the facepiece and lenses to provide good vision, comfort, and proper sealing.

## Why a tight seal is necessary

Tight-fitting respirators cannot provide proper protection without a tight seal between the facepiece and the wearer's face. Consequently, beards and other facial hair, the absence of normally worn dentures, facial deformities, or jewelry or head gear that projects under the facepiece seal can also seriously affect the fit of a facepiece. To ensure proper respiratory protection, employees should check the facepiece each time they wear the respirator. This is done by performing either a positive-pressure or negative-pressure user seal check.

Detailed instructions for performing these user seal checks are in Appendix B-1 of the OSHA respiratory protection standard.

## Fit testing

Fit testing is required for tight-fitting facepiece respirators. Test the effectiveness of the fit of the facepiece two ways: qualitatively and quantitatively.

Qualitative fit testing involves the introduction of a harmless odoriferous or irritating substance into the breathing zone around the respirator being worn. If no odor or irritation is detected by the wearer, this indicates a proper fit.

Quantitative fit testing offers more accurate, detailed information on respirator fit. While the wearer performs exercises that could induce facepiece leakage, a fit testing instrument numerically measures the amount of leakage into the respirator. This testing can be done either by generating a test aerosol as a test atmosphere, using ambient aerosol as a test agent, or using controlled negative pressure to measure any leakage. Detailed instructions for performing qualitative and quantitative fit testing is contained in Appendix A of the OSHA respiratory protection standard.

## How to inspect and take care of respirators

It is important to inspect all respirators for wear and tear before and after each use, giving special attention to rubber or plastic parts that can deteriorate or lose pliability. The facepiece, headband, valves, connecting tube, fittings, cartridges, canisters, or filters must be in good condition. A respirator inspection must include checking the tightness of the connections.

## Monthly inspections

Users must inspect SCBAs at least monthly and ensure that air and oxygen cylinders are fully charged according to the manufacturer's instructions. The inspection should include a check of regulator and warning devices to ensure their proper function. Employers must keep records of inspection dates and findings.

Users should replace chemical cartridges and gas mask canisters as necessary to provide complete protection, following the manufacturer's recommendations. In addition, they should replace mechanical filters as necessary to avoid high resistance to breathing.

## Repairs

Only an experienced person is permitted to make repairs, using parts specifically designed for the respirator. This person must consult the manufacturer's instructions

for any repair and no attempt should be made to repair or replace components or make adjustments or repairs beyond the manufacturer's recommendations.

## **Cleaning**

The employer must ensure that respirators are cleaned and disinfected as often as necessary to keep them sanitary. In addition, the employer must ensure that emergency-use respirators are cleaned and disinfected immediately after each use.

Respirators should be washed in a detergent solution and then disinfected by immersing them in a sanitizing solution. Cleaner-sanitizers that effectively clean the respirator and contain a bactericidal agent are available commercially. The bactericidal agent frequently used is a quaternary ammonium compound. Strong cleaning and sanitizing agents and many solvents can damage rubber or plastic respirator parts. Use these materials with caution or after consultation with the respirator manufacturer.

## **Storage**

Users must store respirators in a way that protects them against dust, sunlight, heat, extreme cold, excessive moisture, and damaging chemicals. When packed or stored, each respirator should be positioned to retain its natural configuration. Facepieces and exhalation valves should rest in a normal position to prevent the rubber or plastic from deforming.

## **Are medical evaluations necessary?**

Workers assigned to tasks that require respirator use must be physically able to perform the work while using the respirator. The local physician or licensed health care professional (LHCP) will determine what health and physical conditions are pertinent.

The medical evaluation can be performed by a physician or other LHCP by using a medical questionnaire or by a medical examination that provides the same information as the questionnaire provided in Appendix C of the OSHA standard. This evaluation must be done before the employee is fit tested and uses the respirator in the workplace. The employer must obtain a written recommendation from the LHCP for each employee's ability to wear a respirator. Additional medical evaluations must be provided whenever healthcare professionals deem them appropriate.

## **How to monitor work areas**

Employers must maintain surveillance of the work area conditions and the degree of worker exposure or stress—a combination of work rate, environmental conditions, and physiological burdens of wearing a respirator. Changes in operating procedures, temperature, air movement, humidity, and work practices may influence the concentration of a substance in the work area atmosphere. Employers must periodically monitor these factors as they affect air contaminant concentrations. In instances where work is of such short duration that it takes longer to do the test than the job, reasonable estimates of exposure are allowable.

## **Immediately dangerous to life or health**

In situations where the environment is or may be immediately dangerous to life or health (IDLH), employers must ensure that one or more employees are located outside the dangerous environment. These employees must maintain visual, voice, or signal line communication with employees in the IDLH atmosphere.

## **Firefighting situations**

In interior structural firefighting situations, employers must ensure that at least two employees enter the structure and remain in visual or voice contact with one another at all times. Also, at least two employees must be located outside the fire area to provide effective emergency rescue. All workers engaged in interior structural firefighting must use SCBA.

## What equipment and air quality standards apply?

Respiratory protective devices must be approved by NIOSH for the contaminant or situation to which the employee is exposed.

### Compressed Gas Association Commodity Specification G-7.1-1989

Compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration must be of high purity. Oxygen must meet the requirements of the United States Pharmacopoeia for medical or breathable oxygen. Breathing air must meet at least the requirement for Grade D breathing air described in Compressed Gas Association (CGA) Commodity Specification G-7.1-1989. Compressed oxygen must not be used in open circuit SCBAs or SARs that have previously used compressed air. Oxygen concentrations greater than 23.5 percent must not be used with airline respirators unless the equipment is designed for oxygen service.

### OSHA and NIOSH

Employers must supply breathing air to respirators from cylinders or air compressors. For testing cylinders, see "Shipping Container Specifications of the Department of Transportation," 49 CFR Part 178. Employers must mark containers of breathing gas clearly and in accordance with NIOSH requirements, as described in 42 CFR Part 84. Further details on the sources of compressed air and its safe use can be found in the CGA pamphlet G-7.1-1989.

### Safety devices and alarms

The compressor for supplying air must have the necessary safety devices and alarms. Compressors must be constructed and situated to prevent contaminated air from entering the air supply system and be equipped with suitable in-line, air-purifying sorbent beds and filters installed to ensure breathing air quality. If using an oil-lubricated compressor, ensure that it has a high-temperature or carbon monoxide

alarm or both. If using only the high-temperature alarm, the employer must test the air from the compressor frequently for carbon monoxide.

### Air-line couplings

Air-line couplings must be incompatible with outlets for other gas systems to prevent accidental servicing of air-line respirators with non-breathable gases or oxygen.

## Head protection

An employer has to make sure that each affected employee wears a protective helmet when working in areas where there is a potential for injury:

- To the head from falling objects, or
- From bumping the head against a fixed object.

Head protection, in the form of protective hats, must do two things—resist penetration and absorb the shock of a blow. This is accomplished by:

- Making the shell of the hat of a material hard enough to resist the blow, and
- Utilizing a shock-absorbing lining composed of headband and crown straps to keep the shell away from the wearer's skull.

Protective hats also are used to protect against electrical shock.

## Why do employees need head protection?

Injuries to the head can be serious and life-threatening. A single head injury can cause permanent disability. Head protection can help prevent these types of injuries.

## What common hazards will hard hats protect employees from?

- Impact from falling or flying objects, or from striking the head against a hard object.
- Penetration by sharp objects.
- Electric shock from contact with energized circuits.

## How can employees protect themselves?

Employees should:

- Wear the hard hat issued to them whenever it's required on the job.
- Adjust the fit of the hard hat so it's comfortable. Make sure the hat is not tilted to one side, and that the straps are not too loose or too tight.
- Never put anything inside the area between the shell and the suspension system (liner).
- Handle the hat with care. Don't drop it, throw it, or sit on it.

## Hard hat inspection and maintenance

Employees should:

- Inspect hard hats before using them. Check the suspension system for stitching that's coming apart and straps that are loose, missing, or torn. Inspect the shell for cracks, scratches, and signs of excessive wear.
- Minimize exposure to sunlight, chemicals, and temperature extremes. (Don't store hard hats on the back window shelf of a vehicle.)
- Replace any hard hat that has been damaged or struck hard by an object.
- Replace the suspension system when it's worn out.
- Clean the hard hat after using (if necessary).
- Wash the hat every month with water and a soap recommended by the hat manufacturer.

## Hard hat routine replacement

Many hard hat manufacturers recommend that a regular head protection replacement program be conducted by employers. Some manufacturers suggest a five year replacement time frame, no matter what shape the hard hat is in.

In environments where there is excessive exposure to temperature extremes, sunlight, or chemicals, replacement could be as often as every two years.

As mentioned before, if a cap has been struck hard by a flying object or the wearer has forcibly struck a fixed object, the hard hat (including the suspension) should be replaced, even if there is no visible damage.

## Stickers on the hard hat

Often, workers will use stickers to “customize” or “decorate” their hard hats. Other times stickers are necessary for marking or identification purposes. The problem with this is that the adhesive stickers can hide cracks or other damage, making it difficult to inspect it properly. It’s best to keep the stickers at least three quarters of an inch from the edge of the helmet and to limit the coverage area of the stickers to a minimum.

## Wearing a hard hat backwards

Hard hats can be worn backwards if they have been tested and found to be compliant to the requirements of the ANSI Z89 standard when worn with the shell turned backwards. However, to do this, the suspension must be reversed in the helmet.

## Hand protection

Everyone gets a cut now and then while working around the house. However, because of the types of hazards workers are exposed to on the job, hand injuries sustained at work can be very serious.

Examples of injuries to arms and hands are burns, cuts, electrical shock, amputation, and absorption of chemicals.

## Employer responsibility

Employers must select, and require employees to use, appropriate hand protection when employees’ hands are exposed to hazards such as those from skin absorption of harmful substances; severe cuts or lacerations; severe abrasions; punctures; chemical burns; thermal burns; and harmful temperature extremes.

There is a wide assortment of gloves, hand pads, sleeves, and wristlets for protection against the above mentioned hazardous situations.

There are many standard and specialty gloves made by hundreds of glove manufacturers. It’s important to perform a hazard analysis to determine exactly what types of gloves are needed.

Workers may need to be protected from more than one type of hazard. For example, when working in a foundry a worker may need to be protected from heat and cuts when handling hot metal. Electricians need special protection from shocks and burns (rubber is considered the best material for insulating gloves and sleeves from these hazards). Employees working with solvents need to have a chemical resistant glove.

The employee should become acquainted with the limitations of the clothing used.

## All gloves are not created equal

To understand the complex nature of glove selection consider the following glove terms:

- Gauge—The gauge is the thickness of the material. The thicker the glove material the less “feel” and flexibility. The thickness is also determined by a glove’s lining. The gauge is usually measured in mils.
- Unlined gloves—Unlined gloves are thinner and give the user more sensitivity. These gloves can contain a powder to make them easier to put on and take off.
- Lined gloves—Gloves can be lined with various materials to make them more comfortable. The thicker the lining, the less the sensitivity or “feel.” Some of the common lined gloves are:

- Knit-lined: Usually cotton or a synthetic material that absorbs perspiration and can give added temperature protection.
- Jersey-lined: Gives best cushioning effect and is most comfortable.
- Flock-lined: Cotton lining makes for easily on/off. Inexpensive.
- Cuffs—Straight cuffs allow for a tight fit around the wrist, protecting against chemicals or other substances from entering the glove. Gauntlet cuffs are longer and offer more protection for the wrist. They are not tight-fitting and allow for easy on/off.
- Glove length—The longer the glove the more protection it offers. The tradeoff is the longer the glove, the higher the cost and the more unwieldy it is to use.

## Selecting a glove

Use the following information to help select a glove that will provide the protection your employees need:

- Perform a risk assessment to determine the hazards workers are exposed to, and the physical conditions the glove will be exposed to.
- Determine the types of features that are needed:
  - palm grip type (rough, smooth);
  - sewn or molded;
  - curved or straight finger design;
  - insulated (for protection against heat or cold);
  - wrist, elbow, or shoulder length;
  - cuff or no cuff;
  - coating (for chemical resistance);
  - cut resistant (usually made of Kevlar fabric).
- Determine the length of the glove by measuring how far the employee will need to immerse their arm into a solution. Take into account any splash protection that is needed.
- Choose the proper size. Gloves that are too tight can cause fatigue and numbness. Ones too loose can fall off or get caught in equipment. Determine the proper size by using a cloth measuring tape to measure around the circumference of the employee hand. Measure around the widest point of the palm. If it's 8 inches then that worker needs a size 8 glove. (Remember actual sizes vary by manufacturer and even by different styles from the same manufacturer.
- Select either a disposable or reusable glove. Some tasks require a disposable glove.

## Foot and leg protection

According to a BLS survey, most of the workers in selected occupations who suffered foot injuries were not wearing protective footwear. Furthermore, most of their employers did not require them to wear safety shoes. The survey found the typical foot injury was caused by objects falling fewer than

4 feet and the median weight was about 65 pounds. Most workers were injured while performing their normal job activities at their worksites.

### **Protection from what?**

For protection of feet and legs from falling or rolling objects, sharp objects, molten metal, hot surfaces, and wet slippery surfaces workers should use appropriate footguards, safety shoes, or boots and leggings.

### **What causes foot injuries?**

#### **Slips and falls**

Employees walking or working in areas where the floor is wet or slippery, or in areas where the floor is cluttered, can be in danger of slipping and falling. Another cause of falling is stepping from elevation (like a work platform) and landing improperly.

Provide workers with appropriate footwear that has the best possible traction, and train them to step carefully, making sure they firmly plant their foot before lifting the other.

#### **Punctures**

Employees often step on sharp objects, puncturing the sole of the shoe, and then the skin. Infection can result, along with bone or nerve damage. That's another reason to train workers to practice good housekeeping.

#### **Falling objects**

As mentioned earlier, most foot injuries are caused by an object falling on the foot. Improper stacking of materials or having a poor grip on an object are usually the cause. Train employees in proper lifting techniques and in how to stack materials. When lifting, get another worker to help you if the load is more than you can safely handle.

#### **Equipment**

Employees' feet can be injured by equipment like forklifts and wheeled carts. Workers need to be aware of equipment operating nearby.

#### **Safety shoes**

Safety shoes should be sturdy and have an impact-resistant toe. These shoes are designed to protect feet from common hazards like falling or rolling objects, cuts, and punctures. On some shoes, the entire toe box and insole are protected by reinforced steel. The instep can also be protected by steel, aluminum, plastic, or other materials to protect against puncture wounds.

Safety shoes come in a variety of styles and materials, such as leather and rubber boots and oxfords.

Safety shoes can also be designed to insulate against temperature extremes. Heat-resistant soled shoes protect against hot surfaces like those found in the roofing, paving, and hot metal industries.

There are also shoes that have special soles to guard against slips, chemicals, and electrical hazards.

## Safety boots

Safety boots offer more protection when splash or spark hazards (chemicals, molten materials) are present:

- When working with corrosives, caustics, cutting oils, and petroleum products, neoprene, or nitrile boots are often required to prevent penetration.
- Foundry or "Gaiter" style boots feature quick-release fasteners or elasticized inserts to allow speedy removal should any hazardous substances get into the boot itself.
- When working with electricity, special electrical hazard boots are available and are designed with no conductive materials other than the steel toe (which is properly insulated).

## Leggings and footguards

Leggings protect the lower leg and feet from molten or welding sparks. Safety snaps permit their rapid removal.

Aluminum alloy, fiberglass, or galvanized steel footguards can be worn over usual work shoes, although they may present the possibility of catching on something and causing workers to trip.

## Overboots

Overboots fit over the employee's normal work footwear and protect the feet from oils, solvents, acids, and other chemicals.

## Selecting foot protection

Make sure the safety shoes and boots meet the ANSI Z41-1991 Standard (which provides both impact and compression protection).

Use the information below to determine what types of safety shoes and boots they need:

<b>If your employees are:</b>	<b>Then they need:</b>
Carrying or handling materials (packages, objects, parts or heavy tools) which could be dropped.	Safety shoes or boots with impact protection.
Performing activities where objects might fall onto the feet.	Safety shoes or boots with impact protection.
Performing activities involving manual material handling carts.	Safety shoes or boots with compression protection.
Working around bulk rolls or heavy pipes.	Safety shoes or boots with compression protection.
Working near sharp objects such as nails, wire, tacks, screws, large staples, scrap metal.	Safety shoes or boots with puncture protection.

## Hearing protection

Exposure to high noise levels can cause hearing loss impairment. It can create physical and psychological stress. Since there is no cure for noise-induced hearing loss, the prevention of excessive noise exposure is the only way to avoid hearing damage. Specifically designed protection is required, depending on the type of noise encountered and the auditory condition of the employee.

OSHA's occupational noise standard at §1910.95 requires companies to provide protection against the effects of noise exposure when the noise levels exceed an 8-hour time-weighted (TWA) average of 90 decibels (dB). In order to determine if your company falls into this category, you need to evaluate noise in your workplace.

To begin a noise evaluation, you should consider these four points:

- Noise level in each work area,
- Equipment and processes that are generating the noise,
- Which employees/job functions are exposed to the noise, and
- Length of exposure to the noise (check production records).

### Monitoring: a critical part of evaluating noise exposure

In order to fully evaluate noise exposure it may be necessary to monitor noise exposure levels. OSHA requires that noise levels be monitored "when information indicates that any employee's exposure may equal or exceed an 8-hour time-weighted average of 85 decibels." **Note:** This 85-dB level also triggers OSHA's requirements to have a hearing conservation program in place. (See §1910.95 (c)-(o))

The exposure measurement must include all continuous, intermittent, and impulsive noise within an 80 dB(A) to 130 dB(A) range and must be taken during a typical work situation.

A preliminary plant-wide noise assessment survey is a good way to locate operations or areas where workers may be exposed to hazardous noise levels. Problem areas warranting additional monitoring include those where it is difficult to communicate in normal tones and where workers have difficulty hearing, or have ringing in their ears after several hours of exposure.

Consider the source of the sound (as a distinct piece of equipment) and the ambient-noise level throughout the facility (a combination of equipment and/or systems) when measuring noise levels at each work station that an employee would occupy during the work shift.

Monitoring should be repeated when changes in production, process, or controls increase noise exposure. Such changes may mean that additional employees need to be monitored, and/or their hearing protectors may no longer provide adequate attenuation. Affected employees are entitled to observe monitoring procedures, and they must be notified of the results of the exposure monitoring.

### The importance of engineering and administrative controls

After becoming aware of a noise problem in your workplace—usually meaning employee exposure levels exceeding an 8-hour TWA of 90 dB, a decision must be made on how to combat the problem. Engineering and administrative controls are essential to putting up an effective fight against workplace noise. According to the National Institute for Occupational Health and Safety (NIOSH) publication, "*A Practical Guide to Preventing Hearing Loss*," engineering and administrative controls represent the first two levels in the hierarchy of controls:

- (1) remove the hazard, or

(2) remove the worker.

The use of these controls should reduce hazardous exposure to the point where the risk to hearing is eliminated or at least more manageable.

## Engineering controls

According to NIOSH, engineering controls are technologically feasible for most noise sources, but their economic feasibility must be determined on a case-by-case basis. In some instances, the application of a relatively simple noise control solution reduces the hazard to the extent that other elements, such as audiometric testing and the use of hearing protection devices are no longer necessary.

In other cases, the noise reduction process may be more complex and must be accomplished in stages over a period of time. Even so, with each reduction of a few decibels, the hazard to hearing is reduced and communication is improved. Noise-related annoyance is also reduced, which could boost worker productivity as the workplace will be more comfortable.

Typical engineering controls involve:

- Reducing noise at the source,
- Interrupting the noise path,
- Reducing reverberation, and
- Reducing structure-borne vibration.

If the noise level in the work area is too high, additional actions may need to be taken to reduce that noise. These steps might include:

- Placing noisy machinery in a separate area away from as many workers as possible;
- Placing machinery on rubber mountings to reduce vibration;
- Using sound-absorbing acoustical tiles and blankets on floors, walls and ceilings; and
- Arranging work schedules to cut down on the time each worker spends in a noisy area.

Manufacturers have also responded to requests to meet noise specifications at the installation and operation level. Since a variety of machinery and equipment can add noise to the workplace, workers, manufacturers and plant operators must all cooperate to reduce noise levels in the workplace.

Some equipment like saws and punch presses just can't be made to run any quieter, so it's up to the employer to provide proper hearing protection.

## Administrative controls

Administrative controls, defined as changes in the work schedule or operations that reduce noise exposure, may also be used effectively. Examples of administrative controls include operating a noisy machine on the second or third shift when fewer people are exposed, or shifting an employee to a less noisy job once a hazardous daily noise dose has been reached.

Generally, administrative controls have limited use in industry because shifting from one job to another is often not possible due to worker skill levels or employee contracts. Moreover, NIOSH says that the practice of rotating employees between quiet and noisy jobs may reduce the risk of

substantial hearing loss in a few workers, but it may actually increase the risk of small hearing loss in many workers.

A more practical administrative control is to provide quiet areas, such as lunch rooms and break rooms, where employees' can gain relief from workplace noise.

## Hearing protection devices

Hearing protection devices (HPDs) are another weapon that can be used against workplace noise. HPD' refer to devices such as earmuffs, earplugs, and hearing bands that can be worn to reduce the level of sound entering the ear. If the noise assessment shows that workers are exposed to excessive noise, and your company is unable to reduce the noise to acceptable levels using engineering and administrative changes, hearing protection must be provided.

## Noise reduction rating (NRR)

When purchasing HPDs it's important to look at the device's NRR. The NRR is a single number rating which is required be shown on the label of each hearing protector sold. The NRR is specified by 40 CFR 211, Product Noise Labeling, Subpart B—Hearing Protection Devices. To simplify things, remember that the higher the NRR

number, the more noise reduction the device provides.

## Earmuffs

Earmuffs cover the entire ear completely. To be effective they need to make a perfect seal around the ear. They can be worn over-the-head or behind-the-neck.

The behind-the-neck style can be used with a hard hat. There are also cap-mounted earmuffs that fit slotted hard hats.

Glasses, long sideburns, long hair, and facial movements, such as chewing, can reduce protection. Special equipment is available for use with glasses, beards, or hard hats.

The NNR for earmuffs can range from 36dB to 20dB.

## Earplugs

Earplugs come in many different styles. Disposable foam earplugs are very common and are an inexpensive way to protect employees' hearing. Usually disposable earplugs are used one time and then thrown away (at the end of the day). Employees should always wash their hands before removing and reinserting disposable plugs. This keeps dirt and other contaminants from entering the ear canal.

Preformed or molded earplugs should be individually fitted by a professional. The non-disposable type should be cleaned after each use for proper protection.

Waxed cotton, foam, or fiberglass wool earplugs are self-forming. When properly inserted, they work as well as most molded earplugs.

The NNR for earplugs can range from 33dB to 6dB.

## Hearing bands

Hearing bands or ear caps are different from earplugs in that they are not inserted completely into the ear canal. They are almost like an earmuff, except without the weight and cost.

The NRR for hearing bands averages between 27dB to 20dB; for hearing caps it is around 17dB.

### **Dual hearing protection**

The idea of dual hearing protection seems a logical response for any worker exposed to high noise. Many employees are under the assumption that wearing an earmuff with a NRR of 28 dB combined with an earplug having a NRR of 24 dB would provide a total attenuation of 52 dB. Unfortunately this is not the way it works in the “real world” of noise reduction.

Because of a condition called *bone conduction*, if noise levels are high enough, sound bypasses the outer and middle ears and stimulates the inner ear via vibration. Therefore, dual protection only adds an additional 5 to 10 dB of noise reduction.

### **Audiometric testing**

It is very important to keep track of workers' hearing by having it tested periodically. An audiometric test is a procedure for checking a person's hearing. Employers with facilities where noise exposure equals or exceeds an average of 85 dBA or more over an eight-hour day are required to provide their employees with audiometric testing.

A trained technician uses an instrument (an audiometer) to send sounds (tones) through headphones. The person being tested responds to the test sounds when they are first heard. The chart that records responses to the test sounds is called an audiogram.

This test is an important part of the effort to conserve and protect workers' hearing. It checks hearing ability so that any hearing loss can be identified and dealt with properly and promptly. Have all affected employees' hearing tested periodically when they're transferred to a noisy work environment or when they're exposed to noise levels that may be dangerous to their hearing.

### **The bottom line—PPE saves lives**

OSHA has mandated PPE for employee protection. However, PPE only works if it's actually worn, and that's what must be firmly communicated to all affected employees.

