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A Guide to Personal Protective Equipment

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This course was adapted from the “North Carolina Department of Labor (NCDOL)”, Publication titled “A Guide to Personal Protective Equipment”, which is in the public domain.

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This guide is intended to be consistent with all existing OSHA standards; therefore, if an area is considered by the reader to be inconsistent with a standard, then the OSHA standard should be followed.

To obtain additional copies of this guide, or if you have questions about N.C. occupational safety and health standards or rules, please contact:

**N.C. Department of Labor
Education, Training and Technical Assistance Bureau
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Additional sources of information are listed on the inside back cover of this guide.

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Contents

Foreword	v
Note	vi
Introduction	1
The Requirement for Personal Protective Equipment	1
The Hazard Assessment	2
Selecting Personal Protective Equipment	2
Training Employees in the Proper Use of Personal Protective Equipment	3
Payment for Personal Protective Equipment	4
Eye and Face Protection	4
Prescription Lenses	4
Eye Protection for Exposed Workers	4
Types of Eye Protection	5
Welding Operations	6
Laser Operations	8
Head Protection	9
Types of Hard Hats	9
Size and Care Considerations	10
Hard Hat Accessories	10
Foot and Leg Protection	11
Special Purpose Shoes	12
Foundry Shoes	12
Care of Protective Footwear	12
Hand and Arm Protection	12
Types of Protective Gloves	12
Leather, Synthetic Fiber or Metal Mesh Gloves	13
Fabric and Coated Fabric Gloves	13
Chemical Protective Gloves	14
Rubber Insulating Gloves	18
Care of Protective Gloves	18
Body Protection	18
Hearing Protection	19
Other Personal Protective Equipment	21
Cooling Vests and Suits	21
High Visibility Clothing	21
Flotation Vests	21
Welding and High Heat	21
List of Tables	
Table 1: Filter Lenses for Protection Against Radiant Energy	7
Table 2: Construction Industry Requirements for Filter Lens Shade Numbers for Protection Against Radiant Energy	8
Table 3: Selecting Laser Safety Glass	8
Table 4: Chemical Resistance Selection Chart for Protective Gloves	15
Table 5: Permissible Noise Exposures	19
Appendix A: NCDOL Standards That Require PPE	22

Foreword

We all know that the best way to avoid dangerous working conditions is to engineer them out of the workplace or to establish rules that keep employees from committing risky job practices. But sometimes, there is simply no way for a worker to avoid spending time in a dangerous atmosphere, doing a job in a loud environment, or being exposed to other conditions that could cause an occupational injury or illness.

Those are the times when a worker must depend on personal protective equipment to protect his or her health. This guide explains how to determine what PPE is needed in a typical workplace and then looks at many different types of equipment.

In North Carolina, the N.C. Department of Labor enforces the federal Occupational Safety and Health Act through a state plan approved by the U.S. Department of Labor. NCDOL offers many educational programs to the public and produces publications to help inform people about their rights and responsibilities regarding occupational safety and health.

When reading this guide, please remember the mission of the N.C. Department of Labor is greater than just regulatory enforcement. An equally important goal is to help citizens find ways to create safe workplaces. Everyone profits when managers and employees work together for safety. This booklet, like the other educational materials produced by the N.C. Department of Labor, can help.

Cherie Berry
Commissioner of Labor

Note

The goal of this booklet is to assist in providing a safe and healthful workplace. Words used in this publication such as “must,” “shall,” “required” and “necessary” indicate requirements under OSHA standards. Procedures indicated by “should,” “may,” “suggested” and “recommended” constitute generally accepted good occupational safety and health practices.

Much of the PPE information in this guide is framed in general terms and is intended to complement relevant regulations and manufacturers’ requirements. For more specific information, refer to the OSHA standards in Title 29, Code of Federal Regulations, Parts 1900–1999. In some instances, the standards referenced in this guide refer to specifications by the American National Standards Institute and the American Society for Testing and Materials.

This guide does not attempt to cover every PPE issue and topic. For example, respiratory protection is not covered in this book. Other guides in this series cover specific PPE-related topics in a more detailed manner, for example, *A Guide to Developing and Maintaining an Effective Hearing Conservation Program* and *A Guide to Fall Prevention in Industry*. (Consult back inside cover for a listing.) Finally, this guide is intended to be consistent with federal and state OSHA standards; however, if an area is considered by the reader to be inconsistent with a standard, then the standard should be followed.

Introduction

Hazards exist in every workplace in many different forms: sharp edges, falling objects, flying sparks, chemicals, noise and a myriad of other potentially dangerous situations. The N.C. Department of Labor’s (NCDOL) Occupational Safety and Health Division requires that employers protect their employees from workplace hazards that can cause injury.

Controlling a hazard at its source is the best way to protect employees. Depending on the hazard and workplace conditions, the employer may be required to use engineering or work practice controls first to manage or eliminate hazards to the greatest extent possible. For example, building a barrier between the hazard and the employees is an engineering control; changing the way in which employees perform their work is a work practice control.

When engineering, work practice and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment to their employees and ensure its use. Personal protective equipment, commonly referred to as “PPE,” is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as gloves, foot and eye protection, protective hearing devices (earplugs, muffs), hard hats, respirators and full body suits.

This guide will help both employers and employees do the following:

- Understand the types of PPE.
- Know the basics of conducting a “hazard assessment” of the workplace.
- Select appropriate PPE for a variety of circumstances.
- Understand what kind of training is needed in the proper use and care of PPE.

The information in this guide is general in nature and does not address all workplace hazards or PPE requirements. The information, methods and procedures in this guide are based on the requirements for PPE as set forth in the Code of Federal Regulations (CFR) at 29 CFR 1910.132 (General requirements); 29 CFR 1910.133 (Eye and face protection); 29 CFR 1910.135 (Head protection); 29 CFR 1910.136 (Foot protection); 29 CFR 1910.137 (Electrical protective equipment); 29 CFR 1910.138 (Hand protection); and regulations that cover the construction industry, NCDOL state specific standard 13 NCAC 07F. 0202; 29 CFR 1926.95 (Criteria for personal protective equipment); 29 CFR 1926.96 (Occupational foot protection); 29 CFR 1926.100 (Head protection); 29 CFR 1926.101 (Hearing protection); and 29 CFR 1926.102 (Eye and face protection); and for the maritime industry at 29 CFR 1915.152 (General requirements); 29 CFR 1915.153 (Eye and face protection); 29 CFR 1915.155 (Head protection); 29 CFR 1915.156 (Foot protection); and 29 CFR 1915.157 (Hand and body protection).

This guide does not address PPE requirements related to respiratory protection (29 CFR 1910.134). There is a brief discussion of hearing protection in this guide, but users should refer to Industry Guide 15, *A Guide to Developing and Maintaining an Effective Hearing Conservation Program*.

The Requirement for Personal Protective Equipment

To ensure the greatest possible protection for employees in the workplace, the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment.

In general, employers are responsible for:

- Performing a “hazard assessment” of the workplace to identify and control physical and health hazards.
- Identifying and providing appropriate PPE for employees.
- Training employees in the use and care of the PPE.
- Maintaining PPE, including replacing worn or damaged PPE.
- Periodically reviewing, updating and evaluating the effectiveness of the PPE program.
- Paying for PPE.

In general, employees should:

- Properly wear PPE.
- Attend training sessions on PPE.
- Care for, clean and maintain PPE.
- Inform a supervisor of the need to repair or replace PPE.

Specific requirements for PPE are presented in many different standards, published in Title 29 of the *Code of Federal Regulations* (29 CFR).

The Hazard Assessment

The first critical step in developing a comprehensive safety and health program is to identify physical and health hazards in the workplace. This process is known as a “hazard assessment.” Potential hazards may be physical or health-related, and a comprehensive hazard assessment should identify hazards in both categories. Examples of physical hazards include moving objects, fluctuating temperatures, high intensity lighting, rolling or pinching objects, electrical connections, and sharp edges. Examples of health hazards include exposure to harmful dusts, chemicals or radiation.

The hazard assessment should begin with a walk-through survey of the facility to develop a list of potential hazards in the following basic hazard categories:

- Impact
- Penetration
- Compression (roll-over) ● Chemical
- Heat/cold
- Harmful dust
- Light (optical) radiation, ● Biological

In addition to noting the basic layout of the facility and reviewing any history of occupational illnesses or injuries, things to look for during the walk-through survey include:

- Sources of electricity.
- Sources of motion such as machines or processes where movement may exist that could result in an impact between

personnel and equipment.

- Sources of high temperatures that could result in burns, eye injuries or fire.
- Types of chemicals used in the workplace.
- Sources of harmful dusts.
- Sources of light radiation, such as welding, brazing, cutting, furnaces, heat treating, high intensity lights. ● The potential for falling or dropping objects.
- Sharp objects that could poke, cut, stab or puncture.
- Biological hazards such as blood or other potentially infectious material.

When the walk-through is complete, the employer should organize and analyze the data so that it may be efficiently used in determining the proper types of PPE required at the worksite. The employer should become aware of the different types of PPE available and the levels of protection offered. It is definitely a good idea to select PPE that will provide a level of protection greater than the minimum required to protect employees from hazards.

The workplace should be periodically reassessed for any changes in conditions, equipment or operating procedures that could affect occupational hazards. This periodic reassessment should also include a review of injury and illness records to spot any trends or areas of concern and taking appropriate corrective action. The suitability of existing PPE, including an evaluation of its condition and age, should be included in the reassessment.

Documentation of the hazard assessment is required through a written certification that includes the following information:

- Identification of the workplace evaluated.
- Name of the person conducting the assessment.
- Date of the assessment.
- Identification of the document certifying completion of the hazard assessment.

Selecting Personal Protective Equipment

All PPE clothing and equipment must be of safe design and construction and should be maintained in a clean and reliable fashion. Employers should take the fit and comfort of PPE into consideration when selecting appropriate items for their workplace. PPE that fits well and is comfortable to wear will encourage employee use of PPE. Most protective devices are available in multiple sizes, and care must be taken to select the proper size for each employee.

If several different types of PPE are worn together, make sure they are compatible. If PPE does not fit properly, it can make the difference between being safely covered or dangerously exposed. It may not provide the level of protection desired and may discourage employee use.

NCDOL requires that many categories of PPE meet or be equivalent to standards developed by the American National Standards Institute (ANSI). ANSI has been preparing safety standards since the 1920s, when the first safety standard was approved to protect the heads and eyes of industrial workers. Employers who need to provide PPE in the categories listed below must make certain that any new equipment procured meets the cited ANSI standard. The employer may also demonstrate that the protective devices in use are at least as effective as PPE constructed in accordance with one of the listed consensus standards. Employers should inform employees who provide their own PPE of the employer's selection decisions and ensure that any employee-owned PPE used in the workplace conforms to the employer's criteria, based on the hazard assessment, NCDOL requirements and ANSI standards. NCDOL requires PPE to meet the following ANSI standards:

- Eye and Face Protection: ANSI Z87.1-2003, ANSI Z87.1-1989 (R-1998) or ANSI Z87.1-1989 (the American National Standard Practice for Occupational and Educational Eye and Face Protection) for the general and maritime industries. The construction industry requires eye and face protection equipment to meet the requirements specified in ANSI Z87.1-1968, Practice for Occupational and Educational Eye and Face Protection.
- Head Protection: ANSI Z89.1-2009, ANSI Z89.1-2003 (the American National Standard for Industrial Head Protection) or ANSI Z89.1-1997 (American National Standard for Personnel Protection—Protective Headwear for Industrial Workers—Requirements) for the general and maritime industries. The construction industry requires helmets used for the protection of employees against impact and penetration of falling and flying objects to meet the specifications contained in ANSI Z89.1-1969 (Safety Requirements for Industrial Head Protection). Helmets for the head protection of employees exposed to high voltage electrical shock and burns must meet the specifications contained in ANSI Z89.2-1971.
- Foot Protection: ASTM F-2412-2005 (Standard Test Methods for Foot Protection) and ASTM F-2413-2005 (Standard Specification for Performance Requirements for Protective Footwear), ANSI Z41-1999 or ANSI Z41-1991 (American National Standard for Personal Protection—Protective Footwear) for the general and maritime industries. Protective footwear used in the construction industry must meet the requirements and specifications in American National Standard for Men's Safety-Toe Footwear, Z41.1-1967.*

For hand protection, there is no ANSI standard for gloves but the standard requires that selection be based upon the tasks to be performed and the performance and construction characteristics of the glove material. For protection against chemicals, glove selection must be based on the chemicals encountered, the chemical resistance and the physical properties of the glove material.

Training Employees in the Proper Use of Personal Protective Equipment

Employers are required to train each employee who must use PPE. Employees must be trained to know at least the following:

- When PPE is necessary.
- What PPE is necessary.
- How to properly put on, take off, adjust and wear the PPE.
- The limitations of the PPE.
- Proper care, maintenance, useful life and disposal of PPE.

Employers must make sure that all employees demonstrate an understanding of the PPE training as well as the ability to wear and use PPE properly before they are allowed to perform work requiring the use of the PPE. If an employer believes that a previously trained employee is not demonstrating the proper understanding and skill level in the use of

*Note: ANSI Z41-1991 replaced ANSI Z41.1-1967. ANSI Z41-1991 was then superseded by ASTM F2412-05, Standard Test Methods for Foot

Protection, and F2413-05, Standard Specification for Performance Requirements for Foot Protection. For the construction industry, NCDOL will accept foot protection designed in accordance with the ASTM standards, current ANSI standards (Z41-1999 or 1991) as well as existing foot protection designed in accordance with ANSI Z41.1 as stated above.

PPE, that employee must receive retraining. Other situations that require additional training or retraining of employees include the following circumstances: changes in the workplace or in the type of required PPE that make prior training obsolete.

Payment for Personal Protective Equipment

On Nov. 15, 2007, OSHA promulgated a final rule titled “Employer Payment for Personal Protective Equipment.” This final rule applies to all industry groups (29 CFR Parts 1910, 1915, 1917, 1918, and 1926). In this rulemaking, OSHA is requiring employers to pay for personal protective equipment where the use of the PPE is required to protect the employee from a work-related hazard. The final rule includes several exceptions for certain items specified in the standard. NCDOL adopted these rules verbatim with the same effective date and payment requirement date as OSHA.

Eye and Face Protection

Employees can be exposed to a large number of hazards that pose danger to their eyes and face. NCDOL requires employers to ensure that employees have appropriate eye or face protection if they are exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, potentially infectious material, or potentially harmful light radiation.

Many occupational eye injuries occur because workers are not wearing any eye protection, while others result from wearing improper or poorly fitting eye protection. Employers must be sure that their employees wear appropriate eye and face protection and that the selected form of protection is appropriate to the work being performed and properly fits each worker exposed to the hazard.

Prescription Lenses

Everyday use of prescription corrective lenses will not provide adequate protection against most occupational eye and face hazards, so employers must make sure that employees with corrective lenses either wear eye protection that incorporates the prescription into the design or wear additional eye protection over their prescription lenses. It is important to ensure that the protective eyewear does not disturb the proper positioning of the prescription lenses so that the employee’s vision will not be inhibited or limited. Also, employees who wear contact lenses must wear eye or face PPE when working in hazardous conditions.

Eye Protection for Exposed Workers

NCDOL suggests that eye protection be routinely considered for use by carpenters, electricians, machinists, mechanics, millwrights, plumbers and pipe fitters, sheet metal workers and tinsmiths, assemblers, sanders, grinding machine operators, sawyers, welders, laborers, chemical process operators and handlers, and timber cutting and logging workers. Employers of workers in other job categories should decide whether there is a need for eye and face PPE through a hazard assessment.

Examples of potential eye or face injuries include:

- Dust, dirt, metal or wood chips entering the eye from activities such as chipping, grinding, sawing, hammering, the use of power tools or even strong wind forces.
- Chemical splashes, mists and vapors from corrosive substances, hot liquids, solvents or other hazardous solutions contacting the eye from activities such as degreasing and electroplating.
- Objects swinging into the eye or face, such as tree limbs, chains, tools or ropes.
- Radiant energy from welding, harmful rays from the use of lasers or other radiant light (as well as heat, glare, sparks, splash and flying particles).

Types of Eye Protection

Selecting the most suitable eye and face protection for employees should take into consideration the following elements:

- Ability to protect against specific workplace hazards.
- Should fit properly and be reasonably comfortable to wear.
- Should provide unrestricted vision and movement.
- Should be durable and cleanable.
- Should allow unrestricted functioning of any other required PPE.

The eye and face protection selected for employee use must clearly identify the manufacturer. Eye and face protective devices used in the general and maritime industries must comply with ANSI Z87.1-2003, ANSI Z87.1-1989 (R-1998) or ANSI Z87.1-1989. Eye and face protective devices that the employer demonstrates are at least as effective as devices that are constructed in accordance with one of the above consensus standards will be acceptable. Eye and face protective devices used in the construction industry must comply with ANSI Z87.1-1968.

An employer may choose to provide one pair of protective eyewear for each position rather than individual eyewear for each employee. To minimize or eliminate the potential for employees to contract infectious diseases from contaminated surfaces, the employer should make sure that employees disinfect shared protective eyewear after each use. Care should be taken when cleaning and sanitizing the protective eyewear so as not to damage any protective coatings. Protective eyewear with corrective lenses may only be used by the employee for whom the corrective prescription was issued and may not be shared among employees.

Some of the most common types of eye and face protection include the following:

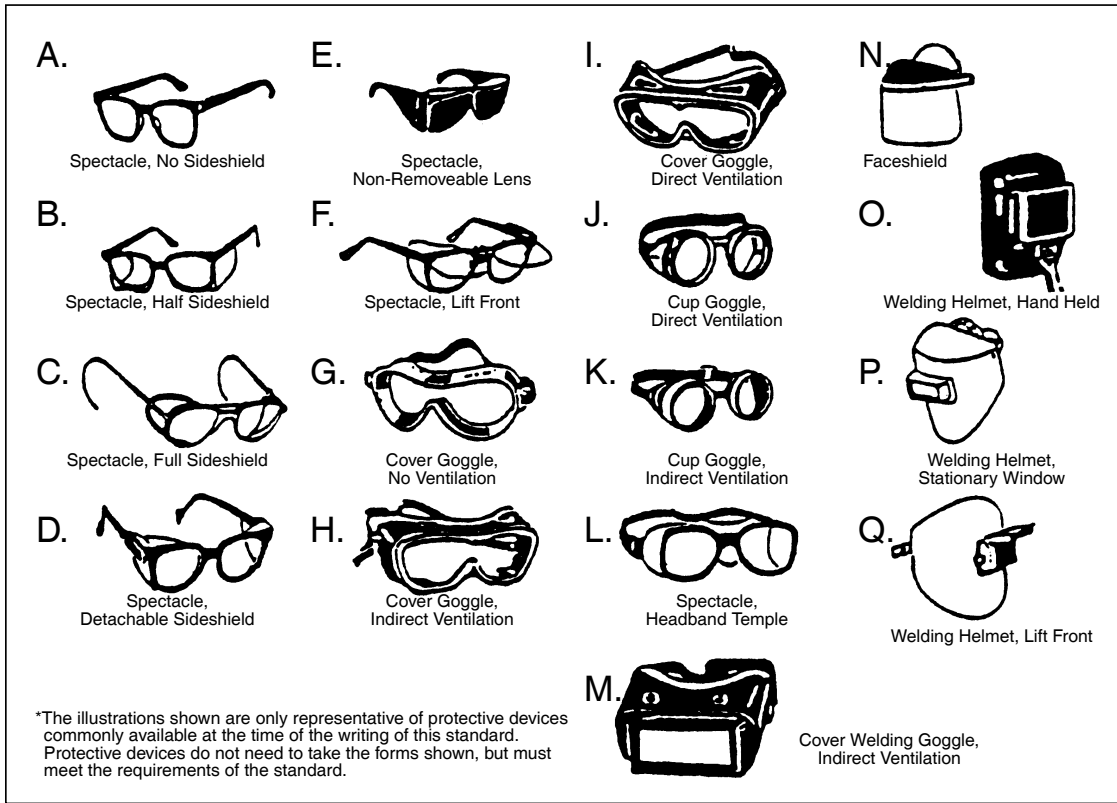
- **Safety spectacles/glasses.** These protective eyeglasses have safety frames constructed of metal or plastic and impact-resistant lenses. Side shields are available on some models. Safety glasses should not be used for protection against chemical splashes, mists or vapors.
- **Goggles.** These are tight-fitting eye protection that completely cover the eyes, eye sockets and the facial area immediately surrounding the eyes and provide protection from impact, dust, mists, vapors and splashes. Goggles with direct ventilation typically are used for impact hazards and dusts, not for protection against chemical splashes or vapors. Goggles with indirect ventilation are used for protection from dusts and splash hazards. Goggles with no ventilation provide protection from dusts, splashes, mists and vapors. Goggles with foam or cloth padding should not be used for chemical splash protection. Some goggles will fit over corrective lenses.
- **Welding shields.** Constructed of vulcanized fiber or fiberglass and fitted with a filtered lens, welding shields protect eyes from burns caused by infrared or intense radiant light; they also protect both the eyes and face from flying sparks, metal spatter and slag chips produced during welding, brazing, soldering and cutting operations. The filter lens shade number must be appropriate to protect against the specific hazards of the work being performed. (See Tables 1 and 2.)
- **Laser safety goggles.** These specialty goggles protect against intense concentrations of light produced by lasers. The type of laser safety goggles an employer chooses will depend upon the equipment and operating conditions in the workplace. (See Table 3.)
- **Face shields.** These protective devices shield the employees' face and eyes from various hazards. Face shields are typically used to provide protection from dust, liquid splash and spray hazards. The face shield windows are available in a variety of materials, shapes, thickness, shades and tints, depending on their particular application. Commonly available windows are transparent sheets of plastic or wire screen. Some are polarized for glare protection. The face shield windows are designed to extend from the eyebrows to below the chin and across the entire width of the employee's head.

Note: Face shields shall be used only in conjunction with spectacles or goggles, providing a higher level of protection to the employees face and eyes.

Each type of protective eyewear is designed to protect against specific hazards. Employers can identify the specific workplace hazards that threaten employees' eyes and faces by completing a hazard assessment as outlined in the earlier section. It is important during the selection process to remember that different product categories are tested at different levels of impact resistance. Figure 1 shows a variety of eye and face PPE.

Figure 1

Eye and Face Protection Devices



Welding Operations

The intense light associated with welding operations can cause serious and sometimes permanent eye damage if operators do not wear proper eye protection. The intensity of light or radiant energy produced by welding, cutting or brazing operations varies according to a number of factors including the task producing the light, the electrode size and the arc current. The following table shows the minimum protective shades for a variety of welding, cutting and brazing operations in general industry and in the shipbuilding industry.

Table 1

Filter Lenses for Protection Against Radiant Energy

Operations	Electrode Size in $\frac{1}{32}$ " (0.8 mm)	Arc Current	Minimum* Protective Shade
Shielded metal arc welding	<3	<60	7
	3–5	60–160	8
	5–8	160–250	10
	>8	250–550	11
Gas metal arc welding and flux cored arc welding		<60	7
		60–160	10
		160–250	10
		250–550	10
Gas tungsten arc welding		<50	8
		50–150	8
		150–500	10
Air carbon	(light)	<500	10
Arc cutting	(heavy)	500–1,000	11
Plasma arc welding		<20	6
		20–100	8
		100–400	10
		400–800	11
Plasma arc cutting	(light)**	<300	8
	(medium)**	300–400	9
	(heavy)**	400–800	10
Torch brazing			3
Torch soldering			2
Carbon arc welding			14

Filter Lenses for Protection Against Radiant Energy

Operations	Plate Thickness inches	Plate Thickness mm	Minimum* Protective Shade
Gas welding: Light	$<\frac{1}{8}$	<3.2	4
Gas welding: Medium	$\frac{1}{8}$ – $\frac{1}{2}$	3.2–12.7	5
Gas welding: Heavy	$>\frac{1}{2}$	>12.7	6
Oxygen cutting: Light	<1	<25	3
Oxygen cutting: Medium	1–6	25–150	4
Oxygen cutting: Heavy	>6	>150	5

*As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade which gives sufficient view of the weld zone without going below the minimum. In oxyfuel gas welding or cutting where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the (spectrum) operation.

**These values apply where the actual arc is clearly seen. Experience has shown that lighter filters may be used when the arc is hidden by the workpiece.

Source: 29 CFR 1910.133(a)(5).

The construction industry has separate requirements for filter lens protective levels for specific types of welding operations, as indicated in Table 2 below.

Table 2

Construction Industry Requirements for Filter Lens Shade Numbers for Protection Against Radiant Energy

Welding Operation	Shade Number
Shielded metal-arc welding $\frac{1}{16}$ - $\frac{5}{16}$ -inch diameter electrodes	10
Gas-shielded arc welding (nonferrous) $\frac{1}{16}$ - $\frac{5}{16}$ -inch diameter electrodes	11
Gas-shielded arc welding (ferrous) $\frac{1}{16}$ - $\frac{7}{16}$ -inch diameter electrodes	12
Shielded metal-arc welding $\frac{3}{16}$ - $\frac{1}{8}$ -inch diameter electrodes	12
$\frac{5}{16}$ -inch diameter electrodes	14
Atomic hydrogen welding	10–14
Carbon-arc welding	14
Soldering	2
Torch brazing	3 or 4
Light cutting, up to 1 inch	3 or 4
Medium cutting, 1 to 6 inches	4 or 5
Heavy cutting, more than 6 inches	5 or 6
Gas welding (light), up to $\frac{1}{8}$ - $\frac{1}{2}$ -inch	4 or 5
Gas welding (medium), to $\frac{1}{2}$ -inch	5 or 6
Gas welding (heavy), more than	6 or 8

Source: 29 CFR 1926.102(b)(1).

Laser Operations

Laser light radiation can be extremely dangerous to the unprotected eye and direct or reflected beams can cause permanent eye damage. Laser retinal burns can be painless, so it is essential that all personnel in or around laser operations wear appropriate eye protection.

Laser safety goggles should protect for the specific wavelength of the laser and must be of sufficient optical density for the energy involved. Safety goggles intended for use with laser beams must be labeled with the laser wavelengths for which they are intended to be used, the optical density of those wavelengths and the visible light transmission.

Table 3 lists maximum power or energy densities and appropriate protection levels for optical densities 5 through 8.

Table 3

Selecting Laser Safety Glass

Intensity, CW maximum power density (watts/cm ²)	Attenuation	
	Optical density (O.D.)	Attenuation factor
10^{-2}	5	10^5
10^{-1}	6	10^6
1.0	7	10^7
10.0	8	10^8

Source: 29 CFR 1926.102(b)(2).

Head Protection

Protecting employees from potential head injuries is a key element of any safety program. A head injury can impair an employee for life or it can be fatal. Wearing a safety helmet or hard hat is one of the easiest ways to protect an employee's head from injury. Hard hats can protect employees from impact and penetration hazards as well as from electrical shock and burn hazards.

Employers must ensure that their employees wear head protection if any of the following apply:

- Objects might fall from above and strike them on the head.
- They might bump their heads against fixed objects, such as exposed pipes or beams.
- There is a possibility of accidental head contact with electrical hazards.

Some examples of occupations in which employees should be required to wear head protection include construction workers, carpenters, electricians, linemen, plumbers and pipe fitters, timber and log cutters, welders, among many others. Whenever there is a danger of objects falling from above, such as working below others who are using tools or working under a conveyor belt, head protection must be worn. Hard hats must be worn with the bill forward to protect employees properly.

In general, protective helmets or hard hats should do the following:

- Resist penetration by objects.
- Absorb the shock of a blow.
- Be water-resistant and slow burning.
- Have clear instructions explaining proper adjustment and replacement of the suspension and headband.

Hard hats must have a hard outer shell and a shock-absorbing lining that incorporates a headband and straps that suspend the shell from 1 to 1¹/₄ inches (2.54 cm to 3.18 cm) away from the head. This type of design provides shock absorption during an impact and ventilation during normal wear.

Protective headgear must meet ANSI Z89.1-2003, ANSI Z89.1-1997 or ANSI Z89.1-1986 for the general and maritime industries. The construction industry requires helmets used for the protection of employees against impact and penetration of falling and flying objects to meet the specifications contained in ANSI Z89.1-1969, and helmets for the head protection of employees exposed to high voltage electrical shock and burns must meet the specifications contained in ANSI Z89.2-1971.

Types of Hard Hats

There are many types of hard hats available in the marketplace today. In addition to selecting protective headgear that meets ANSI standard requirements, employers should ensure that employees wear hard hats that provide appropriate protection against potential workplace hazards. It is important for employers to understand all potential hazards when making this selection, including electrical hazards. This can be done through a comprehensive hazard assessment and an awareness of the different types of protective headgear available.

Hard hats are classified according to the specific impact (types) and electrical performance requirements they are designed to meet (classes). All helmets will meet either Type I or Type II requirements and then shall be further classified by class.

- Type I. Helmets intended to reduce the force of impact resulting from a blow only to the top of the head (vertical impact).
- Type II. Helmets intended to reduce the force of impact resulting from a blow that may be received off center (side impact) or to the top of the head.

Note: ANSI Z89.1-1997 eliminated the old Type 1 and Type II (full brim vs. no encircling brim) design designations. ANSI Z89.1-1986 specified the helmet classes as A, B and C. The 1997 ANSI standard (Z89.1-1997) changed these helmet classes to G, E and C.

- **Class G (General).** Class G helmets are intended to reduce the danger of contact exposure to low-voltage conductors. Test samples are proof-tested at 2,200 volts (phase to ground).

- **Class E (Electrical).** Class E helmets provide the highest level of protection against electrical hazards, with high-voltage shock and burn protection. Test samples are proof-tested at 20,000 volts (phase to ground).
- **Class C (Conductive).** Class C helmets are not intended to provide protection against contact with electrical conductors.

Note: Proof-test voltages for Class G and E helmets are not intended to be an indication of the voltage at which the headgear protects the wearer; but only the level at which they are tested.

Another class of protective headgear on the market is called a “bump hat,” designed for use in areas with low head clearance. Bump hats are recommended for areas where protection is needed from head bumps and lacerations. They are not designed to protect against falling or flying objects and are not ANSI approved.

It is essential to check the type of hard hat employees are using to ensure that the equipment provides appropriate protection. Each hat must bear a label inside the shell that lists the manufacturer, the ANSI designation, the date of manufacture, the type and class of the hat, and the approximate headband size range.

Size and Care Considerations

Head protection that is either too large or too small is inappropriate for use, even if it meets all other requirements. Protective headgear must fit appropriately on the body and for the head size of each individual. Most protective headgear comes in a variety of sizes with adjustable headbands to ensure a proper fit (many adjust in $\frac{1}{8}$ -inch increments). A proper fit should allow sufficient clearance between the shell and the suspension system for ventilation and distribution of an impact. The hat should not bind, slip, fall off or irritate the skin.

Periodic cleaning and inspection will extend the useful life of protective headgear. A daily inspection of the hard hat shell, suspension system and other accessories for holes, cracks, tears or other damage that might compromise the protective value of the hat is essential. Paints, paint thinners and some cleaning agents can weaken the shells of hard hats and may eliminate electrical resistance. Consult the helmet manufacturer for information on the effects of paint and cleaning materials on their hard hats. Never drill holes, paint or apply labels to protective headgear as this may reduce the integrity of the protection. Do not store protective headgear in direct sunlight, such as on the rear window shelf of a car, since sunlight and extreme heat can damage them.

Hard hats with any of the following defects should be removed from service and replaced: ● Perforation, cracking, or deformity of the brim or shell;

- Indication of exposure of the brim or shell to heat, chemicals, or ultraviolet light and other radiation (such as chalking, flaking or loss of surface gloss).

Always replace a hard hat if it sustains an impact, even if damage is not noticeable. Suspension systems are offered as replacement parts and should be replaced when damaged or when excessive wear is noticed. It is not necessary to replace the entire hard hat when deterioration or tears of the suspension systems are noticed.

Some protective headgear allows for the use of various accessories to help employees deal with changing environmental conditions, such as slots for earmuffs, safety glasses, face shields and mounted lights. Optional brims may provide additional protection from the sun and some hats have channels that guide rainwater away from the face. Protective headgear accessories must not compromise the safety elements of the equipment.

Hard Hat Accessories

Faceshield Protection

Faceshield devices can be attached to the helmet without changing the helmet strength and electrical protection. A metal faceshield bracket system can be used on a Class G helmet; however, if a Class E helmet is to be used in an area where Class E protection is required, a type of bracket and shield system that will not conduct electricity (has a dielectric rating) should be used.

Ear Muffs

The required degree of hearing protection should be considered prior to selecting ear muff attachments. If ear muffs are to be attached to helmets, metal attachments are acceptable for Class G helmets. Attachments with a dielectric rating must be used for Class E helmets.

Sweat Bands

If sweat bands are necessary, they must not interfere with the effectiveness of the helmet headband system. Some sweatband devices are made to fit on the headband. For electrical work, metal components must not be used to attach sweat bands to helmets.

Winter Liners

There are many varieties of winter liners. One type fits over the hard hat assembly. It is flame retardant and elasticized to give the user a snug, warm fit. Other styles fit under the helmet. If the liner is to be used with a Class E helmet, it must have a dielectric rating. Regardless of the warmth characteristics, the liner and helmet combination should be compatible. The liner and helmet must fit properly to give the employee proper impact and penetration protection.

Chin Straps

When wind or other conditions present the possibility of the hard hat being accidentally removed from the head, chin straps can be used. If chin straps are used, they should be the type that fastens to the shell of the hard hat. If the chin straps fasten to the headband and suspension system, the shell may blow off and strike another employee.

Foot and Leg Protection

Employees who face possible foot or leg injuries from falling or rolling objects or from crushing or penetrating materials must wear protective footwear. Also, employees whose work involves exposure to hot substances or corrosive or poisonous materials must have protective gear to cover exposed body parts, including legs and feet. If an employee's feet may be exposed to electrical hazards, nonconductive footwear must be worn. On the other hand, workplace exposure to static electricity may necessitate the use of conductive footwear.

Examples of situations in which an employee may be required to wear foot and/or leg protection include: ● When heavy objects such as barrels or tools might roll onto or fall on the employee's feet.

- Working with sharp objects such as nails or spikes that could pierce the soles or uppers of ordinary shoes.
- Exposure to molten metal that might splash on feet or legs.
- Working on or around hot, wet or slippery surfaces.
- Working when electrical hazards are present.

Safety footwear must comply with any of the following consensus standards for the general and maritime industries: ASTM F-2412-2005 and ASTM F-2413-2005 or the ANSI minimum compression and impact performance standards in ANSI Z41-1999 or ANSI Z41-1991, or provide equivalent protection. Safety toe footwear for employees in the construction industry must meet the requirements and specifications in American National Standard for Men's Safety-Toe Footwear, Z41.1-1967.*

Foot and leg protection choices include the following:

- **Leggings** protect the lower legs and feet from heat hazards such as molten metal or welding sparks. Safety snaps allow leggings to be removed quickly.
- **Metatarsal guards** protect the instep area from impact and compression. Made of aluminum, steel, fiber or plastic, these guards may be strapped to the outside of shoes. Footwear designed to newer versions of ANSI Z41 and the ASTM standards require metatarsal protection to be built into the footwear.
- **Toe guards** fit over the toes of regular shoes to protect the toes from impact and compression hazards. They may be made of steel, aluminum or plastic.

Note: ANSI Z41-1991 requires the toe box be incorporated into the footwear during construction and shall be an integral part of the footwear. An employer who chooses to provide employees with toe guards must demonstrate that they are as equally protective as the ANSI Z41-1991 standard.

- **Combination foot and shin guards** protect the lower legs and feet, and may be used in combination with toe guards when greater protection is needed.

*Note: ANSI Z41-1991 replaced ANSI Z41.1-1967. ANSI Z41-1991 was then superseded by ASTM F2412-05, Standard Test Methods for Foot Protection, and F2413-05, Standard Specification for Performance Requirements for Foot Protection. For the construction industry, NCDOL will accept foot protection designed in accordance with the ASTM standards, current ANSI standards (Z41 1999 or 1991) as well as existing foot protection designed in accordance with ANSI Z41.1 as stated above.

- **Safety shoes** have impact-resistant toes and heat-resistant soles that protect the feet against hot work surfaces common in roofing, paving and hot metal industries. The metal insoles of some safety shoes protect against puncture wounds. Safety shoes may also be designed to be electrically conductive to prevent the buildup of static electricity in areas with the potential for explosive atmospheres or nonconductive to protect workers from workplace electrical hazards.

Special Purpose Shoes

Electrically conductive shoes provide protection against the buildup of static electricity. Employees working in explosive and hazardous locations such as explosives manufacturing facilities or grain elevators must wear conductive shoes to reduce the risk of static electricity buildup on the body that could produce a spark and cause an explosion or fire. Foot powder should not be used in conjunction with protective conductive footwear because it provides insulation, reducing the conductive ability of the shoes. Silk, wool and nylon socks can produce static electricity and should not be worn with conductive footwear. Conductive shoes must be removed when the task requiring their use is completed. Note: Employees exposed to electrical hazards must never wear conductive shoes.

Electrical hazard, safety-toe shoes are nonconductive and will prevent the wearers' feet from completing an electrical circuit to the ground. These shoes can protect against open circuits of up to 600 volts in dry conditions and should be used in conjunction with other insulating equipment and additional precautions to reduce the risk of a worker becoming a path for hazardous electrical energy. The insulating protection of electrical hazard, safety-toe shoes may be compromised if the shoes become wet, the soles are worn through, metal particles become embedded in the sole or heel, or workers touch conductive grounded items. Note: Nonconductive footwear must not be used in explosive or hazardous locations.

Foundry Shoes

In addition to insulating the feet from the extreme heat of molten metal, foundry shoes keep hot metal from lodging in shoe eyelets, tongues or other shoe parts. These snug-fitting leather or leather-substitute shoes have leather or rubber soles and rubber heels. All foundry shoes must have built-in safety toes.

Care of Protective Footwear

As with all protective equipment, safety footwear should be inspected prior to each use. Shoes and leggings should be checked for wear and tear at reasonable intervals. This includes looking for cracks or holes, separation of materials, broken buckles or laces. The soles of shoes should be checked for pieces of metal or other embedded items that could present electrical or tripping hazards. Employees should follow the manufacturers' recommendations for cleaning and maintenance of protective footwear.

Hand and Arm Protection

If a workplace hazard assessment reveals that employees face potential injury to hands and arms that cannot be eliminated through engineering and work practice controls, employers must ensure that employees wear appropriate protection. Potential hazards include skin absorption of harmful substances, chemical or thermal burns, electrical dangers, bruises, abrasions, cuts, punctures, fractures and amputations. Protective equipment includes gloves, finger guards, and arm coverings or elbow-length gloves.

Employers should explore all possible engineering and work practice controls to eliminate hazards and use PPE to provide additional protection against hazards that cannot be completely eliminated through other means. For example, machine guards may eliminate a hazard. Installing a barrier to prevent workers from placing their hands at the point of contact between a table saw blade and the item being cut is another example of an engineering control.

Types of Protective Gloves

There are many types of gloves available today to protect against a wide variety of hazards. The nature of the hazard and the operation involved will affect the selection of gloves. The variety of potential occupational hand injuries makes selecting the right pair of gloves challenging. NCDOL is unaware of any gloves that provide protection against all potential hand hazards. It is essential that employees use gloves specifically designed for the hazards and tasks found in their

workplace because gloves designed for one function may not protect against a different function even though they may appear to be an appropriate protective device.

The following are examples of some factors that may influence the selection of protective gloves for a workplace.

- Type of chemicals handled (toxic properties of the chemical(s)).
- Chemical concentration and temperature (the higher the concentration and temperature, the shorter the breakthrough time).
- Nature of contact (total immersion, continual contact, splash, etc.)
- Duration of contact.
- Area requiring protection (hand only, forearm, arm).
- Degree of dexterity (fine motor work).
- Grip requirements (dry, wet, oily).
- Thermal protection.
- Size and comfort.
- Abrasion/cut resistance requirements.
- Other job hazards (such as biological, electrical, and radiation hazards).
- Gloves made from a wide variety of materials are designed for many types of workplace hazards. In general, gloves fall into four groups:
 - Gloves made of leather, synthetic fibers or metal mesh.
 - Fabric and coated fabric gloves.
 - Chemical protective gloves.
 - Insulating rubber gloves (See 29 CFR 1910.137, Electrical Protective Equipment, for detailed requirements on the selection, use and care of insulating rubber gloves).

Leather, Synthetic Fiber or Metal Mesh Gloves

Sturdy gloves made from metal mesh, leather or canvas provide protection against cuts and burns. Leather or canvas gloves also protect against sustained heat.

- **Leather gloves** protect against sparks, moderate heat, blows, chips and rough objects. These gloves can be used for tasks such as welding.
- **Aluminized gloves** provide radiant heat protection by reflection and insulate/reduce heat conduction with a liner or insert. Employees working with molten materials would benefit from this type of glove.
- **Aramid fiber gloves** such as Kevlar, protect against heat, are cut- and abrasion-resistant and wear well. Employees working in jobs such as firefighting, automotive work, metal fabrication, glass and ceramic handling would benefit from this type of glove.
- **Synthetic gloves** of various materials offer protection against heat and cold, are cut- and abrasion-resistant and may withstand some diluted acids. These materials do not stand up against alkalis and solvents.
- **Metal mesh** hand, wrist, arm and finger protective wear protects against knife cuts; however, it offers very little, if any, protection against punctures. Plastic dots can be adhered to the metal mesh to facilitate gripping.

Fabric and Coated Fabric Gloves

Fabric and coated fabric gloves are made of cotton or other fabric to provide varying degrees of protection.

- **Fabric gloves** protect against dirt, slivers, chafing and abrasions. They do not provide sufficient protection for use with rough, sharp or heavy materials. Adding a plastic coating will strengthen some fabric gloves.
- **Coated fabric gloves** are normally made from cotton flannel with napping on one side. By coating the unnapped side with plastic, fabric gloves are transformed into general-purpose hand protection offering slip-resistant qualities. These gloves are used for tasks ranging from handling bricks and wire to chemical laboratory containers. When selecting gloves to protect against chemical exposure hazards, always check with the manufacturer or review the manufacturer's product literature to determine the gloves' effectiveness against specific workplace chemicals and conditions.

Chemical Protective Gloves

Chemical protective gloves are made with different kinds of rubber: natural, butyl, neoprene, nitrile and fluorocarbon (Viton); or various kinds of plastic: polyvinyl chloride (PVC), polyvinyl alcohol and polyethylene. These materials can be blended or laminated for better performance. As a general rule, the thicker the glove material, the greater the chemical resistance, but thick gloves may impair grip and dexterity, having a negative impact on safety. Different glove materials resist different chemicals, and glove compatibility can vary from manufacturer to manufacturer. Select the glove material that is most resistant to the chemicals being used.

Some examples of chemical-resistant gloves include:

- **Butyl gloves** are made of a synthetic rubber and protect against a wide variety of chemicals, such as peroxide, rocket fuels, highly corrosive acids (nitric acid, sulfuric acid, hydrofluoric acid and red-fuming nitric acid), strong bases, alcohols, aldehydes, ketones, esters and nitro compounds. Butyl gloves also resist oxidation, ozone corrosion and abrasion, and remain flexible at low temperatures. Butyl rubber does not perform well with aliphatic and aromatic hydrocarbons and halogenated solvents.
- **Natural (latex) rubber gloves** are comfortable to wear, which makes them a popular general-purpose glove. They feature outstanding tensile strength, elasticity and temperature resistance. In addition to resisting abrasions caused by grinding and polishing, these gloves protect workers' hands from most water solutions of acids, alkalis, salts and ketones. Latex gloves have caused allergic reactions in some individuals and may not be appropriate for all employees. Hypoallergenic gloves, glove liners and powderless gloves are possible alternatives for workers who are allergic to latex gloves.
- **Neoprene gloves** are made of synthetic rubber and offer good pliability and finger dexterity, and are high density and tear resistant. They protect against hydraulic fluids, gasoline, alcohols, organic acids and alkalis. They generally have chemical and wear resistance properties superior to those made of natural rubber.
- **Nitrile gloves** are made of a copolymer and provide protection from chlorinated solvents such as trichloroethylene and perchloroethylene. Although intended for jobs requiring dexterity and sensitivity, nitrile gloves stand up to heavy use even after prolonged exposure to substances that cause other gloves to deteriorate. They offer protection when working with oils, greases, acids, caustics and alcohols but are generally not recommended for use with strong oxidizing agents, aromatic solvents, ketones and acetates.

Additionally, choosing the most appropriate/compatible glove material is further complicated for tasks involving a mixture of chemicals. OSHA recommends in section 11(C) of the non-mandatory Appendix B to Subpart I, Guidelines for Hazard Assessment and Personal Protective Equipment Selection, "For mixtures and formulated products (unless specific test data are available), a glove should be selected on the basis of the chemical component with the shortest breakthrough time, since it is possible for solvents to carry active ingredients through polymeric materials."

The following table from the U.S. Department of Energy (Occupational Safety and Health Technical Reference Manual) rates various gloves as being protective against specific chemicals and will help you select the most appropriate gloves to protect your employees. The ratings are abbreviated as follows: VG: Very Good; G: Good; F: Fair; P: Poor (not recommended). Chemicals marked with an asterisk (*) are for limited service.

Table 4

Chemical Resistance Selection Chart for Protective Gloves

Chemical	Neoprene	Latex/Rubber	Butyl	Nitrile
Acetaldehyde*	VG	G	VG	G
Acetic acid	VG	VG	VG	VG
Acetone*	G	VG	VG	P
Ammonium hydroxide	VG	VG	VG	VG
Amyl acetate*	F	P	F	P
Aniline	G	F	F	P
Benzaldehyde*	F	F	G	G
Benzene*	P	P	P	F
Butyl acetate	G	F	F	P
Butyl alcohol	VG	VG	VG	VG
Carbon disulfide	F	F	F	F
Carbon tetrachloride*	F	P	P	G
Castor oil	F	P	F	VG
Chlorobenzene*	F	P	F	p
Chloroform*	G	P	P	F
Chloronaphthalene	F	P	F	F
Chromic acid (50%)	F	P	F	F
Citric acid (10%)	VG	VG	VG	VG
Cyclohexanol	G	F	G	VG
Dibutyl phthalate*	G	P	G	G
Diesel fuel	G	P	P	VG
Diisobutyl ketone	P	F	G	P
Dimethylformamide	F	F	G	G
Diocetyl phthalate	G	P	F	VG
Dioxane	VG	G	G	G
Epoxy resins, dry	VG	VG	VG	VG
Ethyl acetate*	G	F	G	F
Ethyl alcohol	VG	VG	VG	VG
Ethyl ether*	VG	G	VG	G
Ethylene dichloride*	F	P	F	P
Ethylene glycol	VG	VG	VG	VG
Formaldehyde	VG	VG	VG	VG

Table 4 (continued)

Chemical Resistance Selection Chart for Protective Gloves

Chemical	Neoprene	Latex/Rubber	Butyl	Nitrile
Formic acid	VG	VG	VG	VG
Freon 11	G	P	F	G
Freon 12	G	P	F	G
Freon 21	G	P	F	G
Freon 22	G	P	F	G
Furfural*	G	G	G	G
Gasoline, leaded	G	P	F	VG
Gasoline, unleaded	G	P	F	VG
Glycerin	VG	VG	VG	VG
Hexane	F	P	P	G
Hydrazine (65%)	F	G	G	G
Hydrochloric acid	VG	G	G	G
Hydrofluoric acid (48%)	VG	G	G	G
Hydrogen peroxide (30%)	G	G	G	G
Hydroquinone	G	G	G	F
Isooctane	F	P	P	VG
Kerosene	VG	F	F	VG
Ketones	G	VG	VG	P
Lacquer thinners	G	F	F	P
Lactic acid (85%)	VG	VG	VG	VG
Lauric acid (36%)	VG	F	VG	VG
Lineolic acid	VG	P	F	G
Linseed oil	VG	P	F	VG
Maleic acid	VG	VG	VG	VG
Methyl alcohol	VG	VG	VG	VG
Methylamine	F	F	G	G
Methyl bromide	G	F	G	F
Methyl chloride*	P	P	P	P
Methyl ethyl ketone*	G	G	VG	P
Methyl isobutyl ketone*	F	F	VG	P
Methyl methacrylate	G	G	VG	F
Monoethanolamine	VG	G	VG	VG
Moxpholine	VG	VG	VG	G
Naphthalene	G	F	F	G
Napthas, aliphatic	VG	F	F	VG
Napthas, aromatic	G	P	P	G

Table 4 (continued)

Chemical Resistance Selection Chart for Protective Gloves

Chemical	Neoprene	Latex/Rubber	Butyl	Nitrile
Nitric acid*	G	F	F	F
Nitric acid, red and white fuming	P	P	P	P
Nitromethane (95.5%)*	F	P	F	F
Nitropropane (95.5%)	F	P	F	F
Octyl alcohol	VG	VG	VG	VG
Oleic acid	VG	F	G	VG
Oxalic acid	VG	VG	VG	VG
Palmitic acid	VG	VG	VG	VG
Perchloric acid (60%)	VG	F	G	G
Perchloroethylene	F	P	P	G
Petroleum distillates (naphtha)	G	P	P	VG
Phenol	VG	F	G	F
Phosphoric acid	VG	G	VG	VG
Potassium hydroxide	VG	VG	VG	VG
Propyl acetate	G	F	G	F
Propyl alcohol	VG	VG	VG	VG
Propyl alcohol (iso)	VG	VG	VG	VG
Sodium hydroxide	VG	VG	VG	VG
Styrene	P	P	P	F
Styrene (100%)	P	P	P	F
Sulfuric acid	G	G	G	G
Tannic acid (65%)	VG	VG	VG	VG
Tetrahydrofuran	P	F	F	F
Toluene*	F	P	P	F
Toluene diisocyanate (TDI)	F	G	G	F
Trichloroethylene*	F	F	P	G
Triethanolamine (85%)	VG	G	G	VG
Tung oil	VG	P	F	VG
Turpentine	G	F	F	VG
Xylene*	P	P	P	F

Note: When selecting chemical-resistant gloves, be sure to consult the manufacturer's recommendations, especially if the gloved hand(s) will be immersed in the chemical.

Rubber Insulating Gloves

Employers must make certain that rubber devices to protect against electrical shock are appropriately selected. Rubber insulating gloves that meet the requirements of ASTM D120 are considered appropriate to comply with NCDOL standards. These gloves are available to meet different voltage exposures. Lightweight low voltage gloves are for use on voltages under 1,000. Gloves for use on high voltage are of thicker material for the dielectric strength. As the use voltage rating increases so does the glove weight. Rubber gloves must be visually inspected and an “air” test must be performed before they are used. Electrical protective equipment must be subjected to periodic electrical tests. Test voltages and the maximum intervals between tests must be in accordance with the appropriate OSHA standards.

Care of Protective Gloves

Protective gloves should be inspected before each use to ensure that they are not torn, punctured or made ineffective in any way. A visual inspection will help detect cuts or tears, but a more thorough inspection by filling the gloves with water and tightly rolling the cuff towards the fingers will help reveal any pinhole leaks. Gloves that are discolored or stiff may also indicate deficiencies caused by excessive use, age or degradation from chemical exposure.

Any gloves with impaired protective ability must be discarded and replaced. Reuse of chemical-resistant gloves should be evaluated carefully, taking into consideration the absorptive qualities of the gloves. A decision to reuse chemically exposed gloves should take into consideration the toxicity of the chemicals involved and factors such as duration of exposure, storage and temperature.

Body Protection

Employees who face possible bodily injury of any kind that cannot be eliminated through engineering, work practice or administrative controls, must wear appropriate body protection while performing their jobs. In addition to cuts and radiation, the following are examples of workplace hazards that could cause bodily injury:

- Temperature extremes
- Hot splashes from molten metals and other hot liquid
- Potential impacts from tools, machinery and materials
- Hazardous chemicals

There are many varieties of protective clothing available for specific hazards. Employers are required to ensure that their employees wear personal protective equipment only for the parts of the body exposed to possible injury. Examples of body protection include laboratory coats, coveralls, vests, jackets, aprons, surgical gowns and full body suits. Full body suits can be further classified into fully encapsulating suits, non-encapsulating suits, firefighter’s protective clothing, proximity or approach clothing, blast or fragmentation suits, and radiation protective suits. All of which would necessitate the use of protective boots, gloves and hoods as well.

If a hazard assessment indicates a need for full body protection against toxic substances or harmful physical agents, the clothing must be carefully inspected before each use, it must fit each worker properly and it must function properly and for the purpose for which it is intended. Totally encapsulating chemical protective suits must be capable of maintaining positive air pressure and preventing inward test gas leakage of more than 0.5 percent.

Protective clothing comes in a variety of materials, each effective against particular hazards, such as:

- **Paper-like fiber** is used for disposable suits provide protection against dust and splashes.
- **Treated wool and cotton** adapts well to changing temperatures, is comfortable and fire-resistant, and protects against dust, abrasions and rough and irritating surfaces.
- **Duck** is a closely woven cotton fabric that protects against cuts and bruises when handling heavy, sharp or rough materials.
- **Leather** is often used to protect against dry heat and flames.
- **Rubber, rubberized fabrics, neoprene and plastics** protect against certain chemicals and physical hazards. When chemical or physical hazards are present, check with the clothing manufacturer to ensure that the material selected will provide protection against the specific hazard.

As with chemical protective gloves, the selection of appropriate chemical protective clothing involves a variety of factors. Examples of factors that influence the selection include: the type of chemicals handled, the physical environment (site hazards), duration of contact, nature of contact (total immersion, splash, vapor or gas), PPE use and the accommodation of other selected ensemble equipment, decontamination and disposal, and limitations during temperature extremes, heat stress and other medical considerations.

Hearing Protection

Determining the need to provide hearing protection for employees can be challenging. Employee exposure to excessive noise depends upon a number of factors, including:

- The loudness of the noise as measured in decibels (dB).
- The duration of each employee's exposure to the noise.
- Whether employees move between work areas with different noise levels. Whether noise is generated from one or multiple sources.

Generally, the louder the noise, the shorter the exposure time before hearing protection is required. For instance, employees may be exposed to a noise level of 90 dB for 8 hours per day (unless they experience a Standard Threshold Shift) before hearing protection is required. On the other hand, if the noise level reaches 115 dB, hearing protection is required if the anticipated exposure exceeds 15 minutes.

For a more detailed discussion of the requirements for a comprehensive hearing conservation program, see Industry Guide 15, *A Guide to Developing and Maintaining an Effective Hearing Conservation Program*, or refer to the standard at 29 CFR 1910.95, Occupational Noise Exposure, paragraph (c).

Table 5 shows the permissible noise exposures that require hearing protection for employees exposed to occupational noise at specific decibel levels for specific time periods. Noises are considered continuous if the interval between occurrences of the maximum noise level is one second or less. Noises not meeting this definition are considered impact or impulse noises (loud momentary explosions of sound) and exposures to this type of noise must not exceed 140 dB. Examples of situations or tools that may result in impact or impulse noises are powder-actuated nail guns, a punch press or drop hammers.

Table 5
Permissible Noise Exposures

Duration per day, in hours	Sound level in Db*
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

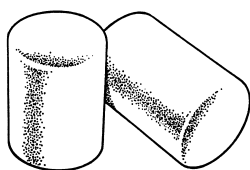
*When measured on the A scale of a standard sound level meter at slow response.

Source: 29 CFR 1910.95, Table G-16.

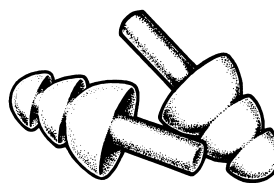
If engineering and work practice controls do not lower employee exposure to workplace noise to acceptable levels, employees must wear appropriate hearing protection. It is important to understand that hearing protectors reduce only the amount of noise that gets through to the ears. The amount of this reduction is referred to as attenuation, which differs according to the type of hearing protection used and how well it fits. Hearing protectors worn by employees must reduce an employee's noise exposure to within the acceptable limits noted in Table 5. Refer to Appendix B of 29 CFR 1910.95, Occupational Noise Exposure, for detailed information on methods to estimate the attenuation effectiveness of hearing protectors based on the device's noise reduction rating (NRR). Manufacturers of hearing protection devices must display the device's NRR on the product packaging. If employees are exposed to occupational noise at or above 85 dB averaged over an eight-hour period, the employer is required to institute a hearing conservation program that includes regular testing of employees' hearing by qualified professionals. Refer to 29 CFR 1910.95(c) for a description of the requirements for a hearing conservation program. Figure 2 shows four types of hearing protection.

Figure 2

Types of Hearing Protection



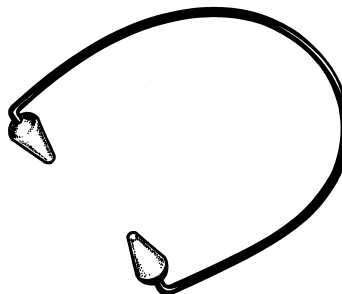
Formable foam earplugs expand to fit ear canals of different sizes and shapes.



Preformed earplugs may come in from one to five sizes to fit different ear canals.



Earmuffs cover the ear to block out noise.



Semi-aural HPDs or canal caps are convenient for brief periods of noise exposures.

Some types of hearing protection include:

- **Earplugs** are inserted into the ear canal to provide a seal against the canal walls. *Formable foam* or “roll-down” earplugs are rolled between the fingers to compress them for proper fit. They can be made from polyvinyl chloride or polyurethane. *Preformed* earplugs are made of flexible vinyl materials and come in different sizes. *Custom molded* earplugs are made from impressions of the individual employee's ear canal.
- **Semiaurals or banded earplugs** are small stoppers that seal against the entrance to the ear canal by force of a band worn under the chin or behind the neck. They typically provide less protection than earplugs or earmuffs. They are most suitable for short-term use, as they are less comfortable than other devices.
- **Earmuffs** enclose the entire external ears inside rigid cups. The inside of the cup is filled with acoustic foam, and the perimeter of the cup is fitted with a cushion that seals against the head around the ear by force of the headband. Glasses, facial hair, long hair or facial movements such as chewing may reduce the protective value of earmuffs.

- **Helmets or Hard Hats** with either built in or attached hearing protection are not typically used in industrial settings but are common in the logging industry, the military and in recreational sports.

Other Personal Protective Equipment

Cooling Vests and Suits

Personal cooling vests and suits are available for wear in operations involving extreme heat conditions. One design requires the use of a supplied air system. The air enters the vest or coverall through a tube in which it is cooled by as much as 40 degrees. The cooled air is channeled out over the upper torso and around the neck area when only the vest is being used. When the coverall or full body cooling type of PPE is used, the cooling air is also channeled to the leg and arm areas.

There is also a type of body cooling system that does not require an electrical, air or water supply. This vest is made of durable flame-resistant cotton shell fabric. Sewn underneath the outer shell are layers of light metallic insulation that reflect radiant heat outward and cooling inward toward the body. Pouch-like areas are accessible for quick and easy installation of segmented, semi-frozen gel cooling packets. These gel packs, often referred to as plastic ice, provide approximately twice the cooling effect of the same volume of water ice. The gel packs will not leak, even if punctured. They can be refrozen overnight in an ordinary freezer.

Other systems use supplied cooling air and a manifold system of tubes to channel the cool air to the body extremities. Outer surfaces are frequently made of aluminum or other heat-reflective material, depending on the type and source of the heat conditions.

High Visibility Apparel

High visibility apparel must be used by workers involved in traffic control, such as flaggers or law enforcement officers, or for employees who work on the roadways, such as sanitation, utility or construction workers, and emergency responders. The apparel should be high visibility orange, yellow, yellow-green or a fluorescent version. Apparel can be procured with reflective and/or luminescent trim, or vertical or horizontal stripes, which offers greater day and night visibility. ANSI/ISEA 107 provides guidance for the selection of high visibility apparel. Additionally, in 29 CFR 1926.201, Signaling, warning apparel used by flaggers must conform to Part VI of the Manual on Uniform Traffic Control Devices (1988 Edition, Revision 3 or the Millennium Edition.)

Flotation Vests

NCDOL standard 29 CFR 1926.106(a) requires that employees working over or near water, where the danger of drowning exists, be provided with approved life jackets or buoyant work vests. These vests are available as flotation pads inside high visibility international orange nylon shells or as vinyl coated flotation pads of international orange. The flotation vests must be U.S. Coast Guard approved.

Additionally, in any other workplace where employees work over or near water, or use boats, appropriate approved life jackets, buoyant work vests or other flotation devices must be provided.

Welding and High Heat

Coverall, jackets, pants and aprons are available for operations involving high heat or molten metal splashes. Leather is the traditional protective material for many welding operations. Where there is exposure to radiant heat as well as molten metal splashes, aluminized garments may be used. They reflect up to 95 percent of the radiant heat. Flame-resistant cotton coveralls designed for comfort as well as protection are sometimes preferred. Whatever the type of clothing used for welding operations, it should not have external pockets or cuffs. Fabrics of silica, ceramic and fiberglass eliminate the need for asbestos and are now available for welding operations. These fabrics are available in many combinations of color and weight. The fabrics are functional over a temperature range of 700 to 2,000 degrees Fahrenheit.

Appendix A: NCDOL Standards That Require PPE

29 CFR 1910: General Industry

1910.28 Safety requirements for scaffolding	1910.261 Pulp, paper, and paperboard mills
1910.66 Powered platforms for building maintenance	1910.262 Textiles
1910.67 Vehicle-mounted elevating and rotating work platforms	1910.268 Telecommunications
1910.94 Ventilation	1910.269 Electric power generation, transmission and distribution
1910.95 Occupational noise exposure	1910.333 Selection and use of work practices (Electrical)
1910.119 Process safety management of highly hazardous chemicals	1910.335 Safeguards for personnel protection (Electrical)
1910.120 Hazardous waste operations and emergency response	1910.1000 Air contaminants
1910.132 General requirements (personal protective equipment)	1910.1001 Asbestos
1910.133 Eye and face protection	1910.1003 13 carcinogens, etc.
1910.134 Respiratory protection	1910.1017 Vinyl chloride
1910.135 Head protection	1910.1018 Inorganic arsenic
1910.136 Foot protection	1910.1025 Lead
1910.137 Electrical protective equipment	1910.1026 Chromium (VI)
1910.138 Hand protection	1910.1027 Cadmium
1910.146 Permit-required confined spaces	1910.1028 Benzene
1910.156 Fire brigades	1910.1029 Coke oven emissions
1910.157 Portable fire extinguishers	1910.1030 Bloodborne pathogens
1910.160 Fixed extinguishing systems, general	1910.1043 Cotton dust
1910.183 Helicopters	1910.1044 1,2-dibromo-3-chloropropane
1910.218 Forging machines	1910.1045 Acrylonitrile
1910.242 Hand and portable powered tools and equipment, general	1910.1047 Ethylene oxide
1910.243 Guarding of portable powered tools	1910.1048 Formaldehyde
1910.252 General requirements (Welding, cutting and brazing)	1910.1050 Methylenedianiline
	1910.1051 1,3-Butadiene
	1910.1052 Methylene chloride
	1910.1096 Ionizing radiation
	1910.1450 Occupational exposure to chemicals in laboratories

29 CFR 1915: Shipyard Employment

1915.12 Precautions and the order of testing before entering confined and enclosed spaces and other dangerous atmospheres	1915.77 Working surfaces
1915.13 Cleaning and other cold work	1915.135 Powder actuated fastening tools
1915.32 Toxic cleaning solvents	1915.154 Respiratory protection
1915.34 Mechanical paint removers	1915.155 Head protection
1915.35 Painting	1915.156 Foot protection
1915.51 Ventilation and protection in welding, cutting and heating	1915.157 Hand and body protection
1915.73 Guarding of deck openings and edges	1915.158 Lifesaving equipment
	1915.159 Personal fall arrest systems (PFAS)
	1915.1001 Asbestos
	1915.1026 Chromium (VI)

29 CFR 1917: Marine Terminals

1917.22 Hazardous cargo	1917.93 Head protection
1917.25 Fumigants, pesticides, insecticides and hazardous preservatives	1917.94 Foot protection
1917.26 First aid and lifesaving facilities	1917.95 Other protective measures
1917.91 Eye and face protection	1917.126 River banks
1917.92 Respiratory protection	1917.152 Welding, cutting and heating (hot work)
	1917.154 Compressed air

29 CFR 1926: Construction

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|---|---|
| 1926.52 Occupational noise exposure | 1926.353 Ventilation and protection in welding, cutting and heating |
| 1926.57 Ventilation | 1926.354 Welding, cutting and heating in way of preservative coatings |
| 1926.60 Methylenedianiline | 1926.416 General requirements (Electrical) |
| 1926.62 Lead | 1926.451 General requirements (Scaffolds) |
| 1926.64 Process safety management of highly hazardous chemicals | 1926.453 Aerial lifts |
| 1926.65 Hazardous waste operations and emergency response | 1926.501 Duty to have fall protection |
| 1926.95 Criteria for personal protective equipment | 1926.502 Fall protection systems criteria and practices |
| 1926.96 Occupational foot protection | 1926.550 Cranes and derricks |
| 1926.100 Head protection | 1926.551 Helicopters |
| 1926.101 Hearing protection | 1926.701 General requirements (Concrete and masonry construction) |
| 1926.102 Eye and face protection | 1926.760 Fall protection (Steel erection) |
| 1926.103 Respiratory protection | 1926.800 Underground construction |
| 1926.104 Safety belts, lifelines and lanyards | 1926.951 Tools and protective equipment (Power transmission and distribution) |
| 1926.105 Safety nets | 1926.955 Overhead lines |
| 1926.106 Working over or near water | 1926.1101 Asbestos |
| 1926.250 General requirements for storage | 1926.1126 Chromium (VI) |
| 1926.300 General requirements (Hand and power tools) | 1926.1127 Cadmium |
| 1926.302 Power-operated hand tools | |
| 1926.304 Woodworking tools | |
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 | |
| 13 NCAC 07F .0202—General Safety and Health Provisions | 13 NCAC 07F .0604(d)—Hazard Identification and Assessment |
| 13 NCAC 07F .0204—Personal Protective and Life Saving Equipment | 13 NCAC 07F .0605—Fall Protection |
| 13 NCAC 07F .0206—Power Transmission and Distribution | 13 NCAC 07F .0605(i)(2)(B) and (C)—Emergency and Rescue Procedures |

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Occupational Safety and Health (OSH) Sources of Information

You may call 1-800-NC-LABOR (1-800-625-2267) to reach any division of the N.C. Department of Labor; or visit the NCDOL home page on the World Wide Web: <http://www.nclabor.com>.

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Mailing Address:
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Raleigh, NC 27699-1101
Local Telephone: 919-807-2900 Fax: 919-807-2856

Physical Location:
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Raleigh, NC 27699-1101
Telephone: 919-807-2875 Fax: 919-807-2876

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Raleigh, NC 27699-1101
Telephone: 919-807-2899 Fax: 919-807-2902

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Telephone: 919-807-2923 Fax: 919-807-2924

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Safety and Health Compliance District Offices

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