

Eye Protection

OVERVIEW OF EYE PROTECTION

We have already discussed the issue of laser safety and solar protection. Next we will consider the more general topic of protecting the eye from foreign material such as flying debris, chemicals, etc. *The law requires that employers protect workers in hazardous areas, but eye safety is also important at home, in sports, and for children during ordinary play.*

OCCUPATIONAL EYE SAFETY

The video, *In the Blink of an Eye*, produced by Prevent Blindness America, introduces several important principles about occupational eye safety.

- Eye injuries at work place occur far too often—about 1,000 per day in the United States
- Often these injuries are easily preventable, IF workers would simply wear their eye protection. A very important part of eye care is to *teach your patients the importance of wearing their eye protection* if they work in hazardous areas.
- Regular spectacles do not provide adequate protection. Patients who work in eye hazardous jobs need *safety lenses in safety frames*. Both the lenses and frames can be identified by special markings. Safety frames have **Z87.1** printed on them, and the *lenses have the optical lab's logo*.
- Safety glasses should have *side shields* in most cases.
- For some situations, safety glasses plus goggles are necessary.
- When safety hoods or shields are worn, the patients should still be wearing safety glasses underneath.

INSTANT EXPERTISE FROM Z87.1

The ANSI standard known as Z87.1 describes the basic principles of eye protection and provides a convenient system for deciding which kind of protection is required for specific kinds of hazards. I will be referring to the figures in the 1989 version of ANSI Z87.1, which is the same version our videotapes refer to. OSHA regulations still require compliance to the 1989 standard, although a newer standard was issued in 2003 (ANSI Z87.1 - 2003).

The 2003 standard uses many of the same principles described in the 1989 version, but it designated two levels of impact protection for lenses:

- Standard – 1-inch steel ball dropped from fifty inches. Marked with manufacturer's logo, such as "AOS" for AO Safety. Minimum thickness = 3 mm (2.5 mm for >+3.00 D)
- High-impact – quarter-inch steel ball shot at high-velocity (150 ft/sec for safety glasses, 250 ft/sec for goggles, 300 ft/sec for face shields). Marked with the logo and a "+" sign, such as "AOS+" or "AOSZ87+." No minimum thickness requirement for plano lenses, but prescription lenses must be at least 2 mm thick.

An additional penetration test is required for all plano safety glasses.

All frames must be strong enough to retain the lenses during impact testing. This is indicated by "Z87" printed on the frame or "Z87-2" for frames designed for prescription lenses that comply with the 2003 standard.

In general, if safety glasses are recommended, you should use lenses that pass the new ANSI high-impact standard (Z87+). See the following references:

http://www.titmus.com/ansi_whitepaper.htm
<http://www.safetyglassesusa.com/ansiz8712003.html>
<http://www.labsafety.com/refinfo/ezfacts/ezf251.htm>
<http://www.tasco-safety.com/sglasses/ansi.html>

The following discussion and figures refer to the 1989 standard, which is available in the NSU library. With a basic understanding of eye protection, and the information contained in the booklet, **ANSI Z87.1-1989 Practice for occupational and educational eye and face protection** (American National Standards Institute), you will be ready to prescribe the correct protective eye wear for your patients. This is an important area that is easily overlooked by clinicians, but by applying a few simple principles you can establish yourself as an industrial vision expert.

This booklet summarizes the basic information you must know to correctly prescribe occupational eye protection. The Selection Chart and figure of protective devices provide a “cookbook” for choosing the right protection based upon the type of hazard. Eye hazards are grouped into 5 categories:

- Impact - grinding, machining, riveting, etc.
- Heat - furnace operations, casting, etc.
- Chemical - acid and chemical handling, decreasing, etc.
- Dust - wood shops, dusty work areas, etc.
- Optical radiation - welding

Use the following steps to determine the correct type of eye protection for a particular occupational hazard.

- 1) From the Selection Chart find the relevant hazard category that applies. Within the major category, there may be subcategories.
- 2) In the row for that category find the code and description for the appropriate protector type.
- 3) Refer to the figure to see a picture of the type of eye protection matching the code.
- 4) On the Selection Chart note other information for that kind of hazard and eye protection.
- 5) Prescribe the appropriate eye protection.

Example 1: A patient uses strong cleaning fluids at his job. You ask about eye protection, and the patient says he is using spectacles with polycarbonate lenses. Is this good enough? Check the Selection Chart.

chemical ... splash ... protectors G, H, K.

These are described as, “Goggles, eyecup and cover types. For severe exposures, add N (face shield).

See the figure for examples of the appropriate eye protection.

Additional recommendation from the selection chart: ventilation should be adequate but protected from splash entry. Spectacles, welding helmets, hand shields are NOT RECOMMENDED.

For welding, protection depends on the type of welding. This is also summarized in Z87.1. Protection usually consists of a “filter lens” (darkly tinted lens) plus a face shield.

Example 2: For arc welding ... O, P, Q (welding helmets). Filter lens shades 10-14 are recommended depending on the type of welding. Table 1 (page 25) of ANSI Z87.1 summarizes UV, IR & visible % transmittance of the shade numbers. Excerpts are shown in Table 1 below.

Table 1. Transmission of the welding filter shade numbers in the UV, visible and IR bands.

<i>Filter shade #</i>	<i>% UV</i>	<i>% visible</i>	<i>%IR</i>
3	0.07	13.9	9.0
4	.04	5.18	5.0
8	.004	0.1	1.0
10	.001	0.0139	0.6
14	.0001	0.00027	0.3

For more details, see Borish Chapter 25, or Chapter 15 “Protecting the Eye from Welding” by Donald G. Pitts, in Environmental Vision, by Dr. Pitts (Butterworth-Heinemann, 1993).

Some occupations present more than one type of hazard, so eye protection should *protect against ALL hazards*. For example, a job with impact and chemical hazards will probably require BOTH safety glasses and goggles.

Use ANSI Z87.1 as your “cheat sheet” when patients need your advice on occupational eye safety. This small booklet and the information contained in it summarizes the most important basic data you need to know to correctly prescribe personal protective equipment (**PPE**) for the eyes.

The new ANSI Z87.1-2003 standard is available for purchase from the American Society of Safety Engineers (<http://www.asse.org/>).

Laser protection is a separate issue and is described in ANSI Z136.1-1993, *Safe Use of Lasers*.

YOUR OBLIGATION TO PROTECT YOUR PATIENTS

The first step toward eye safety is a complete eye examination. Simply providing patients with good vision will help them avoid hazards. During your case history, be alert to any potentially hazardous activities your patient may be exposed to either at work, at home or during recreational activities. As an optometrist, you have a **duty to warn** your patients of eye hazards, and you could be held legally liable if you neglect this part of your patient care. Quoting from an article by a optometrist-lawyer, Dr. Pamela Miller,

A cause of [legal] action for Negligence generally asserts that the prescriber had a duty or obligation to the patient, which he or she breaches, and the patient was subsequently injured. The duty to warn a patient of the advantages and disadvantages of a particular lens (i.e. failure to obtain informed consent), the failure to prescribe the lens material of choice, the failure to inspect and verify the lens material, all contribute to a legal basis for this action.

In general, if you knew, or should have known, that a patient was engaged in an activity that required protection, then you have an obligation to educate and inform the patient about his or her alternatives. The prudent practitioner would also document as part of the patient's record, all pertinent information. In many

instances, that obligation extends past the patient to include informing the parent or guardian of the options and your recommendations. Those cases include where the patient is a minor, is incapacitated, or is otherwise incompetent.

So, if you know, or should have known that your patient is exposed to ocular hazards, either at work or elsewhere, you must recommend the appropriate lens material and frame to protect him.

OPHTHALMIC LENS MATERIALS

Glass lenses are generally not used in safety glasses, and even for dress spectacles, ANSI requires that glass be either heat or chemical treated, to improve impact resistance. If correctly treated they should be able to withstand the impact of a one-inch steel ball dropped from a height of 50 inches. For low-velocity, low-mass objects, it is stronger than CR-39. *If scratched, a glass lens loses its impact resistance and becomes very dangerous.* When glass lenses break on impact, they shatter into many small sharp pieces.

CR-39 plastic lenses can be used for safety glasses, but they must have a *minimum thickness of 3.0 mm (the new standard refers to a 2.0-mm thickness for high-impact protection).* They are not shatter proof, and when they break, CR-39 lenses also shatter into large jagged pieces.

Polycarbonate is far superior to CR-39 for impact protection and is generally the material of choice for providing impact protection. Polycarbonate is also used to make bulletproof glass.

In order to meet ANSI Z87.1 standards for basic impact resistance, the lenses must have a minimum thickness of 3.0 mm. Prescription plus lenses of over +3.00 diopters may have a minimum edge thickness of 2.5 mm. Safety lenses are required to have the optical lab logo imprinted on the surface and must be mounted in Z87 approved safety frames. These have "Z87" stamped on the frame. Both plastic and metal safety frames are available.

You should not mix regular lenses with safety frames or visa versa. Side shields are highly recommended. For indoor work, tinted lenses or photochromics may reduce visibility and are normally not recommended. In summary, remember the following:

- Proper spectacle Rx for good vision
- Duty to warn
- Polycarb is the material of choice (except for high prescriptions)
- Lab logo on lenses
- Z87 on the frames
- Both safety frames and lenses
- Use side shields

HOME EYE SAFETY

The Occupational Safety and Health Administration, known as OSHA, mandated (OSHA 29 CFR 1910.133(a) Eye and Face Protection) that employers take steps to protect employees who are exposed to eye hazards on the job and this has resulted in a great decrease in on-the-job eye injuries. Unfortunately, eye hazards at home are often overlooked.

Quoting from the former Pacific University eye safety web page

With the evolution in eyecare protection impacting the work place, why hasn't the same emphasis hit the home yet? A surprising 41% of all eye injuries take place in the home. What is more alarming is how these injuries are happening.

Trimming the bushes, operating power tools, and cleaning with household chemicals all pose critical eye dangers, ranging from burning eyes to losing eyesight. But still the thought of wearing eye protection has not entered the consumers' minds.

Every household should have plano safety glasses with side shields that can be used worn alone or over spectacles. You should educate your patients to wear them whenever they are exposed to eye hazards at home.

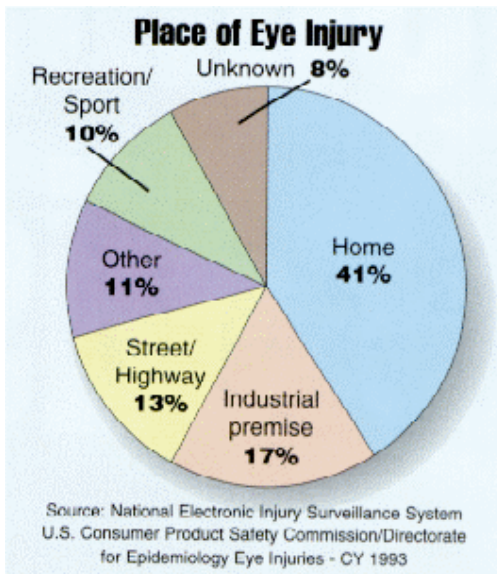


Figure 1. Site of injuries.

SPORTS INJURIES

A substantial number of eye injuries occur during sports. The most dangerous sports, in terms of rates of eye injuries are baseball, basketball and racquet sports, but almost any sport presents some potential hazard to the eyes. *Athletes should therefore wear eye protection (safety glasses or face shields) made of polycarbonate.* Depending on the nature of the hazard, side protection may also be necessary.

At one time lensless protectors were sold for racquet sports, however these are useless, since a high-speed ball can squeeze past the rim and impact the eye. Also, racquetball athletes should NOT wear regular spectacles!

CHILDREN

It is important to educate parents that children also often need eye protection, depending on their activities. The leading cause of injuries to children, including eye injuries, is traffic accidents. But many preventable eye injuries are caused by common toys or objects found around the home. Table 2 estimates the number of eye injuries to small children (less than age 5) by cause, and Table 3 shows a similar breakdown for older (age 5-14) children. (From: <http://www.pacificu.edu/titmus/html/statistics.html>) For a table showing the breakdown for different types of toys, see <http://www.pacificu.edu/titmus/html/children.html>. Besides toy weapons, toys listed include playground equipment, flying toys, balloons, toy make-up kits or cosmetics. Because of their exposure to eye hazards such as these, *polycarbonate lenses are the recommended material to use when prescribing spectacles for children.*

Table 2. Causes of eye injuries to children less than age 5 in 1994

Product category	Estimated injuries	Percent of total
Toys	2,660	9.8
Household cleaners	1,886	6.9
Cigarettes, cigars, etc.	1,731	6.4
Adhesives	1,077	4.0
Tables	951	3.5
Laundry soaps	666	2.4
Gasoline	665	2.4
Drinking straws	623	2.3
Bleaches	649	2.3
Total	27,250	100

Table 3. Causes of eye injuries to children age 5 to 14 in 1994

Category	Estimated injuries	Percent of total
Toys	4,099	9.1
Baseball	3,460	7.7
Basketball	2,717	6.0
Adhesives	1,732	3.8
Swimming pools	1,687	3.7
BB and pellet guns	1,595	3.5
Pens and pencils	1,595	3.5
Bicycles	1,365	3.0
Football	1,011	2.4
Aerosol containers	994	2.4
Total	45,050	100

POLYCARBONATE LENSES

Because it is at least sixty times stronger than other ophthalmic materials, polycarbonate is the material of choice for safety eyewear and for regular spectacles if eye protection is a concern. In addition to its strength, polycarbonate offers other advantages: it is a high index plastic (n=1.59), is lighter than CR-39, and provides excellent UV protection even without a tint.

One disadvantage is its high chromatic dispersion, indicated by its low Abbe number (32). Because of this, optical quality with polycarbonate lenses may not be as good as with other materials for high prescriptions (beyond -4.00 or +6.00).

In general, polycarbonate lenses are recommended for all patients in the following categories:

- children
- athletes
- monocular patients
- amblyopes
- anyone exposed to impact hazards at home or work.