Keeping an Eye on Lab Safety

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Making something perfectly clear will totally confuse most people.
Why should a company have a safety eyewear program?

😊It’s estimated that about only 50% of the workplaces in the US are currently compliant to the eye safety standard.

😊Since the mid 1980’s, workplace eye injuries have decreased from over 3,000 per day to approximately 1,000 per day.

😊Of the remaining 1,000 eye injuries each day, the overwhelming majority occur because the worker is not wearing eye protection, or they are wearing the wrong kind of eye protection for the job.
Why should a company have a safety eyewear program?

- The Bureau of Labor Statistics estimates the average cost of a disabling eye injury at $2,949 in indemnity compensation and $994 for medical payments.

- This results in a total cost to American industry of $354,870,000. per year. This figure does not include other indirect costs such as lost time, production slowdowns, etc.
The Purpose of a Safety Program

- Provides a solution for protecting the employees’ eyes.
- Helps prevent Workers’ Compensation expenses.
- Decreases medical & operating expenses.
- Increases manufacturing efficiencies through optimum employee vision.
- Shows concern for the well-being of the employees.
- Is necessary for meeting OSHA requirements.
…and it’s the LAW!

- **OSHA 29 CFR 1910.132**
  - General Industry
    - Personal Protective Equipment
      - General Requirements
- **OSHA 29 CFR 1910.133**
  - General Industry
    - Personal Protective Equipment
      - Eye and Face Protection
- **OSHA 29 CFR 1926.102**
  - Construction
    - Personal Protective Equipment
      - Eye and Face Protection
- **OSHA**
  - All regulations are available at www.osha.gov
OSHA 29 CFR 1910.133

(a) General Requirements. (1) Each affected employee shall use appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation.
(2) Each affected employee shall use eye protection that provides side protection when there is a hazard from flying objects. Detachable side protectors (e.g. clip-on or slide-on side shields) meeting the pertinent requirements of this section are acceptable.
What is the ANSI Z87.1-2003 Standard?

The ANSI Z87.1 standard is the:

“Practice for Occupational and Educational Personal Eye and Face Protection Devices.”
ANSI Standards

- Are reviewed every 5 years
- Must be revised, reaffirmed, or withdrawn by the 10th anniversary date
- The newest standard was revised effective 19 August 2003
The major changes:

- Now sets down a performance standard, rather than just product strength.
- There are now 2 levels of impact protection:
  - Basic Impact
  - High Impact
- Thinner prescription lenses will be allowed, if they meet the High Impact testing requirements.
- Frames must be tested to ensure their ability to retain a 2.0mm High Impact lens when exposed to high impact.
- A warning label (to be removed only by the wearer) must be affixed to prescriptions not meeting the High Impact criteria (Basic Impact).
What is a Hazard Assessment?

- Survey of the work area - determine types of hazards
- Identify sources of hazards - walk-through survey
- Organize gathered information
- Assess protective devices - assure proper fit, comfort and protective ability
Eye Safety in the Workplace

- Foreign Objects
- Safety Lenses
- Safety Frames
- Contact Lenses
- Eye Wash Stations
- Functional Vision Requirements
What are some typical eye hazards?

- When chipping, grinding, sawing, drilling, sanding, welding, plating, handling chemicals, buffing, working in dusty conditions, brazing, casting, machining, riveting, or performing other similar tasks.
- Safety glasses should also be worn when working near these operations.
Eye Safety in the Workplace

Foreign Objects

- Flying objects like wood, metal, stone chips, nails, etc.
- Dangerous chemicals
- Fumes and gases
- UV rays from welding
Eye Safety in the Workplace

Safety Glasses

- **Frames**- street wear is not acceptable
- **Lenses**- polycarbonate is king!
- **Fit**- must be a firm fit and not fall off or slip; use a strap to secure
- **Cleaning**- a dirty lens affects vision; watch for fogging
- **Storing**- store in a safe place where they won’t get stepped on
- **Replace**- scratched, broken, bent or ill-fitted should be replaced
Who needs safety glasses?

- The OSHA regulations specify that anyone exposed to hazardous conditions that could cause an eye injury MUST wear eye protection.
- A selection chart is provided, as part of the ANSI Z87.1-2003 standard, giving specific information on the type of eyewear needed.
Eye Safety in the Workplace

Types of Safety Glasses

- Safety glasses with side shields (or wrap around)
- Face shields (used with other eye protection)
- Goggles with regular ventilation
- Goggles with hooded ventilation
- Welding helmets
ANSI Z87.1 Definitions

- **Primary Protection**: A device that may be worn alone or in conjunction with a secondary protector.
- **Secondary Protection**: A device that shall be worn only in conjunction with a primary protector.
- **Face Shield**: A protective device commonly worn to shield the wearer’s face and/or eyes from certain hazards. (considered secondary)
HOW TO RECOGNIZE SAFETY GLASSES

Frames
Safety frames are stronger than street-wear frames and are heat-resistant. They help prevent lenses from being pushed into your eyes.

Frame imprint: All safety frames that meet ANSI standards have the imprint “Z87” stamped on them.

Lenses
Safety glasses that meet ANSI standards have glass or polycarbonate lenses. They are stronger than street-wear lenses, are more impact-resistant, and come in prescription and nonprescription (plano) forms.

Lens marking: The manufacturer’s identification or monogram appears on the top of each safety lens that meets ANSI standards.
The 2003 ANSI standard, as with the 1989 standard, does recommend side protection when there is a danger of injury due to impact from flying particles.

- The new standard requires greater lateral protection if shields are needed. This translates into greater coverage.
Side Protection

- Check with the manufacturer to determine whether the design of the shields you use meets the new standard.
  - If the shields are not made to the new design, they should be replaced.
- The marking on the shields has not changed from the previous standard.
Complaints About Sideshields

(I’m sure you’ve heard them all!)

– “My field of vision is obstructed.”
– “I can’t see if something is coming from the side, so I shouldn’t be wearing shields.”
– “What do I need them for, anyway?”
The Effects of Sideshields on Peripheral Vision

- The US Naval Weapons Center China Lake California performed a study in January of 1982 to determine the degradation of peripheral vision through sideshields.
- Six types of sideshields were evaluated.
- It was noted that maximum eye movement is normally 35 degrees to left or right and that most shields do not begin to appear until approximately 50 degrees or further.
- It was determined that “visual resolution is not importantly degraded in the peripheral area by any of the sideshields.”
Frame High Mass Impact Test

A manufacturer must perform the High Mass Impact Test on each frame to ensure the ANSI Z87 standard is met.

- The frame, with 2.0 mm plano lenses, is placed on the head form.
- A 17.6 oz. pointed projectile dropped through 50” tube.
- The frame and lenses must remain intact.
- No contact may be made with head form.
What about the lenses?

- With the new ANSI standard, prescription lenses must also meet the testing requirements of the ANSI Z87.1 standard.
- They must be marked appropriately to indicate what level of protection they provide.
- There are now 2 levels of impact protection:
  - Basic Impact
  - High Impact (marked with a “+”)
What’s the difference?

- **Basic Impact**
  - Lenses did not pass testing requirements for High Impact
  - Drop ball test only
    - Glass must be individually tested.
    - CR39 plastic statistical sampling is acceptable

- **High Impact**
  - Minimum 2.0mm thickness
  - High Velocity Impact Test
  - Polycarbonate
2.0mm plano lenses are edged to 55mm and placed in a special beveled fixture for the test procedure.

They must be able to withstand the impact from a ¼” steel ball traveling at 150 ft/sec:
- They must not dislodge from the fixture.
- No parts of the lens may fragment or crack.
The Health Belief Model

Individuals must believe:

- They are susceptible - it can happen to them
- The risk is severe - eye injuries can be serious
- Know the benefits of compliance - protection
- Barriers aren’t prohibitive - they won’t look ugly
An Eye Saved

- As the result of a private contractor’s safety eyewear program, an employee encouraged his eighteen-year-old son, who installs siding on houses, to wear safety glasses.

- The young man finally gave in when aluminum dust started getting into his eyes. About one week later, while applying siding with an air powered staple gun, he fired a staple and it hit a metal plate behind the siding. The staple ricocheted back towards his face and one leg of the staple penetrated the safety glasses' lens.

- The staple hit with such force that the frames were cracked and his eyebrow and cheekbone were bruised. But, his eye was saved.
Who needs safety glasses?

However, personal protectors are NOT a substitute for engineering controls and sounds safety practices.
LASER is an acronym which stands for Light Amplification by Stimulated Emission of Radiation.
Laser Safety

- **Thermal Effects**: a part of the energy of the laser gets absorbed in the material or tissue.

- **Photochemical Effects**: when the wavelength of the laser radiation is sufficiently short, i.e., in the ultraviolet or blue region of the spectrum.
Radiation Absorption

Near-Ultraviolet (315 nm - 390 nm) Radiation

Visible and Near-Infrared (400-1400 nm) Radiation

Mid-Infrared and Far-Infrared (1400 nm - 1 mm) and Middle-Ultraviolet (180 nm - 315 nm) Radiation
Non-Beam Hazards Associated with Laser Use

- Noise
- X-Radiation
- Fire
- Explosion
- Electrical
- Plasma Radiation
- Compressed Gas
- Laser Generated Airborne Contaminants
Laser Regulation

- Center for Devices and Radiological Health (CDRH), (FDA) regulates product performance.
- All laser products sold in the USA since August 1976 must be certified by the manufacturer as meeting certain product performance (safety) standards.
- Each laser must bear a label indicating compliance with the standard and denoting the laser hazard classification.
Laser Hazard Classification

- **Class 1**: laser system is considered to be incapable of producing damaging radiation levels during operation, and exempt from any control measures or other forms of surveillance.

- **Class 1M**: considered to be incapable of producing hazardous exposure conditions during normal operation unless the beam is viewed with an optical instrument such as an eye-loupe (diverging beam) or a telescope (collimated beam)
Laser Hazard Classification

- **Class 2**: emits in the visible portion of the spectrum (400-700 nm), and eye protection is normally afforded by the human aversion response, which is .25 second.

- **Class 2M**: emits in the visible portion of the spectrum (400-700 nm), and eye protection is normally afforded by the human aversion response for unaided viewing but potentially hazardous if viewed with certain optical aids.
Laser Hazard Classification

- **Class 3**: may be hazardous under direct and specular viewing conditions, but is normally not a diffuse reflection hazard or fire hazard.
- **Sub-Class 3B**: laser system has output up to 500mW and may be hazardous under direct and specular viewing conditions, but is normally not a diffuse reflection or fire hazard.
- **Sub-Class 3R**: laser system is potentially hazardous under some direct and specular reflection viewing conditions if the eye is appropriately focused and stable, but the probability of an actual injury is small. This laser will not pose either a fire hazard or diffuse reflection hazard.
Laser Hazard Classification

Class 4: a laser with output greater than 500mW and a hazard to the eye and skin from the direct beam, and may pose a diffuse reflection or fire hazard, and may also produce laser generated airborne contaminants and hazardous plasma radiation. Used for laser displays, laser surgery and cutting metals.
ANSI Z136
Safe Use of Lasers

This standard provides a detailed description of control measures which can be put into place to protect against potential accidents.
ANSI Z136.1

- ANSI Z136.2 - Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources
- ANSI Z136.3 - Safe Use of Lasers in Health Care Facilities
- ANSI Z136.4 - Recommended Practice for Laser Safety Measurements for Hazard Evaluation
- ANSI Z136.5 - Safe Use of Lasers in Educational Institutions
- ANSI Z136.6 - Safe Use of Lasers
Laser Protective Eyewear
Absorptive technology literally absorbs the wavelength of the laser radiation while allowing the non-laser wavelengths to pass through the lenses.

**Warning:** Laser eyewear is only designed to provide protection against the wavelengths listed on the lens. Using the eyewear for any other wavelength can cause serious injury including blindness.
Optical Density

- Optical Density, or O.D. as it is commonly known, refers to the attenuation factor of the filter to the base 10.
- A filter with an OD of 2 attenuates the laser by a factor of $10^2$ or 100
- An OD of 3 attenuates the laser beam by a factor of 1,000
- An OD of 4 by a factor of 10,000.
Laser Web References

- [http://www.creol.ucf.edu/](http://www.creol.ucf.edu/) - College of optics and photonics - University of Central Florida
Eye Safety in Welding

- Eye injuries account for one-quarter of all welding injuries.
- Risk for welding-related eye injuries are workers in industries that produce industrial and commercial machinery, computer equipment, and fabricated metal products.
Eye Safety in Welding

- Welders should wear goggles or safety glasses with side-shields that comply with ANSI Z87.1 under welding helmets.
- Welders should always wear goggles or other suitable eye protection when gas welding or oxygen cutting.
- Goggles provide better protection than safety glasses from impact, dust, and radiation hazards.
Risk Factors in Welding

- Mechanical damage from being struck by flying particles and chipped slag;
- Radiation and photochemical burns from ultraviolet radiation (UVR), infrared radiation, and intense blue light;
- Irritation and chemical burns from fumes and chemicals.
Welder’s Flash

- A very painful but seldom permanent injury that is characterized by eye swelling, tearing, and pain.
- Often a delayed reaction—up to 6-12 hours.
- Caused by UV light absorbed by the cornea.
- Treatment: Flush eyes for 10 minutes
- Eye care professional—antibiotics, aspirin, patching.
### Arc Welding Helmets

- **Fixed shade**- are best for daily jobs that require the same type of welding at the same current levels.
- **Variable shade helmets**- are best for workers with variable welding tasks.
- **Helmet shades** come in a range of darkness levels, rated from 9 to 14 with 14 being darkest, which adjust manually or automatically, depending on the helmet.
Microscopes and Eyestrain
Ergonomically Designed Stereomicroscope

- Swinging Eyepiece Tubes
- Eyepiece
- Eye-Level Risers
- Aperture Diaphragm
- Objective
- Stage
- Base
- Focus Knobs
- Zoom Adjustment
- Pillar
- Binocular Observation Head
Microscopes and Eyestrain
Correct Eyepiece Adjustment

- Adjust both eyepieces to their minimum (+) diopter correction and correct pupillary distance.
- Set step or zoom magnification to maximum.
- Using a flat specimen, obtain the best focus.
- Reduce magnification to minimum. At this stage do not re-adjust main focus.
- Focus with eyepieces separately to obtain a focused image.
- Increase magnification to maximum. A slight re-adjustment of main focus can be used for sharper image.
- The image should stay in focus through maximum and minimum zoom adjustment.
Microscopes and Eyestrain

- Place the microscope on a dark table or place a sheet of black paper or cloth under the microscope.
- Cover the free eye with your hand to get the microscope eye to take the lead. Once the microscope eye is in the lead, remove your hand.
- Other option: use a video camera system that displays the specimen on a computer monitor.
- Use the 3 B approach: Blink, Breathe and Break!
General Purpose Prescription Lenses

- Single Vision
- Bifocals
- Trifocals
- Progressive Addition (PAL)
Progressive Lenses

Distance
Intermediate
Near
Blur Zones
Task Specific Lenses

- Single Vision Readers
- Single Vision Intermediate
- Intermediate/Near Bifocal
- Occupational Progressive Lens (OPAL)
Occupational Progressive

Intermediate Zone

Near Zone
Anti-Reflective Coating

Uncoated lens

Coated lens

Photos courtesy of iCoat Company
Lens Wipes

- Silicone cleaners- for anti-fogging and/or anti-static
- Remove debris from lens PRIOR to wiping
- Use a neutral pH cleaner- affects lenses most
- Confirm types of lens coatings that are acceptable (from cleaner package)
Eye Safety in the Workplace

Contact Lenses

- **Research** - Contact lens wear in industrial environments with potentially hazardous exposures **is safe** when patients wear proper protective ocular devices and when contact lenses do not exacerbate any potential ocular injury.

- **Arc Welding** - **NO** fusing of contact lenses to the cornea

- **Chemical Agents** - Pose a threat through direct physical contact of the agent with the ocular tissues and exposure to fumes, especially 1,2 dibromo-3-chloropropane, ethylene oxide and dianiline methyl chloride.

- **Foreign Bodies** - Can cause severe mechanical trauma with or without contact lenses. May get trapped beneath a lens (usually RGP)
Eye Safety in the Workplace

Contact Lenses

- **Radiation** - Studies show no risk of ocular damage from long term exposure to infrared heaters. UV protectors can be in the form of glasses and contact lenses.

- **Environments** - Dusty and/or chemical environments may represent a hazard.

- **Protection** - They are not a primary protective device.

- **Primary Protection** - Wearers should use appropriate protectors in hazardous environments.
Eye Safety in the Workplace

First Aid

- **Foreign Particles** - flush, do not rub eyes
- **Chemical Splashes** - RINSE continually at least 15 minutes
- **Light (UV) burns** - delayed reaction; close eyes and get attention
- **Cuts near the eye** - loosely bandage both eyes
- **Embedded objects** - do NOT remove object; get immediate attention
- **Bumps and blows** - cold compress
Eye Safety in the Workplace

Eye Wash Stations

- ANSI Requirements
- Eyewash station types
- Flushing solution choices
- Maintenance
Eye Safety in the Workplace

Eye Wash Stations
(ANSI Z358.1-2004)

- Minimum .4 gallon per minute for no less than 15 minutes
- Accessibility - within 10 seconds
- Hands-free operation - employee must hold eyes open
- Area free of obstruction and clearly identified
- Showers vs. eyewash stations - some combination units exist.
Eye Safety in the Workplace

Eye Wash Stations

<table>
<thead>
<tr>
<th>PLUMBLED</th>
<th>PORTABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expensive</td>
<td>Self-contained</td>
</tr>
<tr>
<td>Reliable</td>
<td>Moveable</td>
</tr>
<tr>
<td>Uses tap water</td>
<td>Tap water with preservative</td>
</tr>
<tr>
<td>Consistent supply</td>
<td>Must be monitored</td>
</tr>
</tbody>
</table>
Eye Safety in the Workplace

Eye Wash Stations

- Tap water can be tainted with bacteria.
- Sealed fluid cartridges are buffered.
- Tank solutions expire after six months.
- Hoses- not acceptable!
- Flushing the eye is the most effective first step in treating chemical contamination of the eyes.
Eyewashes and ADA Requirements
Eyewashes and ADA Requirements

- No current ADA guidelines exist
- Equal rights = equal access
- Time frame must be maintained (10 seconds)
- ANSI Z358.1 does not distinguish between accident victims.
- Most entities are trying to comply with both ANSI and ADA.
Eye Safety in the Workplace

Functional Vision Requirements

- Must be able to see the task at hand - without visual stress
- Lighting is critical - is more better?
- Contrast - more is better
- Vision correction - far, intermediate and near distances must be clear
Good vision is that degree of visual function ability, which is adequate to perform the visual task presented.
Vision Screenings

- Pre-employment
- On-going, periodic evaluations
- Types of screening
  - Snellen chart
  - Titmus-type screener
  - Computer-based
- Limits of screenings
Does your safety program address ergonomics-related issues?

- 52% Some ergonomics
- 30% Yes - it's important
- 13% No
- 5% I'm not sure

-NSC opinion poll 8/06
If everything seems to be going well, you've overlooked something.
VISUAL ERGONOMICS HANDBOOK

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