Visible Light Hazards and the Glassworker

Introduction

Most glass workers are all familiar with sodium flare, that annoying ball of yellow light that occurs when glass, most notably soft glass, is exposed to flame. As the glass molecules heat up, the sodium in the glass burns, creating “sodium flare.” Didymium/ACE and our new DASH-40 filter (sold under a variety of trade names by various manufacturers) all remove sodium flare from the wearer’s vision.

While the hazards of UV radiation (UVR) to the eye are well-known to most individuals, the issue of High Energy Visible (HEV) light and High Intensity Visible (HIV) light are not. Since most of the work that glass workers perform does not generate UVR, the main discussion points of this article will focus on the HEV and HIV hazards.

HEV is defined as visible light radiation from 380 nm to 530 nm in the visible light spectrum. In terms of apparent color, these wavelengths correspond to violet to blue-green. As a reference point, sodium flare is at 575 nm.

For the purposes of this article, HIV is defined as luminescence in excess of 10,000 lumens. One lumen is the luminescence of one candle. A 100-watt light bulb emits approximately 120 lumens. Sunlight on a white sand beach can range from 8,000 to 10,000 lumens. Fresh snow on a sunny day can have a luminescence as high as 30,000 lumens.

The Process of Vision

Both visible and “invisible” (UVR and IR [Infrared Radiation]) light consists of energy in the form of photons. As photons strike the retina, the physical force of the photons is converted into chemical energy producing electrical impulses perceived by the brain as “light.” This chemical process uses potassium and sodium ions and sensory cells in the form of rods and cones.

Night Vision Problems

Rod cells are highly sensitive to light, on the order of 4 magnitudes (10,000 times) greater than cone cells.

In low light conditions, a chemical called “visual purple” (rhodopsin) allows the rods to be particularly sensitive to faint sources of light. Visual purple is a combination of a protein called opsin and a light sensitive substance called retinene. Rod cells are elongated cylinders, which contain about 2,000 stacked discs. Within each disc are upwards of 100 million components of visual purple.

Visual purple is extremely reactive to light. Even small amounts of light will cause the “bleaching” of visual purple. During HIV conditions, visual purple is consumed much faster than the body can produce it. When luminance conditions decrease rapidly from HIV levels to relative darkness, the eye is left without a reserve of visual purple. A light adapted eye (one that has been exposed to HIV conditions) will be less sensitive to dark conditions by as much as 10,000 times as an eye that has had at least 40 minutes of exposure to dark conditions.

Prolonged unfiltered exposure to HIV increases the time cycle of visual purple replenishment and can affect an individual's ability to adapt to low light levels. Individuals who spend long periods exposed to HIV are particularly susceptible to longer adaptation times when moving to relative dark conditions.

Glare Problems

Too much light, called glare, can cause discomfort or even disrupt vision. Glare can be broken down into two categories: discomfort glare and disabling glare.

Discomfort glare generally does not degrade vision; however, it is certainly distracting and is capable of causing pain and/or eye fatigue. Discomfort glare commonly results from one of two conditions – excessive amounts of illumination and/or reflections in the visual field. Excessive lighting causes actual pain and discomfort. Surroundings such as sand, water or polished surfaces can also produce discomfort glare.

Eye discomfort is poorly understood since the retina has no pain receptors, there is evidence that suggests that the discomfort felt in bright light is triggered by the constriction (or size decrease) of the pupil. If you have ever forgotten to wear sunglasses on a sunny day, you know the feeling! During and after prolonged exposure to uncomfortably bright conditions, symptoms such as headache, eye and overall fatigue are common. Individuals with light colored eyes are generally more susceptible to the symptoms than individuals with dark colored eyes.

Distracting glare is a form of discomfort glare best noted as the reflection from your eyeglass lens. While such reflections do not decrease visual acuity, they do distract the visual system and may cause passing areas of decreased perception in the visual field. For example, the headlights of a passing car can create glare in the form of "ghost images".

Disabling glare occurs when a light source within the field of view has luminance that is disproportional to the other objects being viewed. The source of the glare may be direct or indirect. A perfect example of this is an object passing close to the viewed sun. The direct luminance of the sun is far brighter than any other object in the sky, obscuring anything near it.

Blinding glare is a form of disabling glare, and occurs when glare is severe enough to prevent useful vision of objects within the field of view. A good example is the reflection of sunlight from a body of water.

One consequence of glare is decreased contrast sensitivity. A 1995 study conducted by an automobile insurance company revealed that driver reaction times were slower in the presence of glare.

AMD

Age-related Macular Degeneration (AMD) is the result of photochemical damage affecting the macula, the central vision portion of the retina. It is the leading cause of blindness in people over the age of 50. The visual effect of AMD can be described as looking at a clock and being able to see the numbers but not the hands. One person in six, by age 55, will develop AMD.

Extended exposure to HEV and HIV may increase the development of AMD. UVR, HEV and HIV have been shown to have a major impact on photoreceptor and retinal pigment epithelium (RPE) cell

function, inducing photochemical damage and cell death in the rods and cones. This may lead to early onset of AMD.

Conclusions

Proper filter eyewear is an absolute requirement for anyone working with hot glass.

Clear lenses do not provide proper filtration of UV, HEV, or HIV wavelengths and should not be worn during any hot glass operation.

Didymium and ACE (Amethyst Color Enhancement) filters by themselves provide safe filtration for soft glass workers but must never be used by borosilicate glass workers without additional visible light filters. If you have light colored eyes, you may wish to consider adding additional filtration depending on your personal sensitivity to bright light. Additional filtration is required by anyone working with glass that contains silver additives or any other material that create bright visible light flares.

Individuals working borosilicate glass must always wear a shaded lens that provides a maximum of 10 to 12 percent visible light at the HEV wavelengths (which translates to a welding shade 3.0). Darker shades must be worn when working with glass that generates very bright visible light flares, such as quartz, or when working with metals such as silver or gold.

Ensure that your eyewear is providing proper filtration. Your supplier should be able to provide a transmission graph showing what your eyewear transmits at specific wavelengths.

References

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