THE EYE-SUN PROTECTION FACTOR (E-SPF®):

A More Complete Way to Look at Ultraviolet Radiation Hazard and Eye Protection

Why Do We Need A "Sun Protection Factor" for Eyewear?

Over the last three decades we have learned that it is critical to protect our skin from the sun. Today, consumers can easily find the sun protection they need by glancing at the sun protection factor (SPF) displayed prominently on daily moisturizers, sunscreens, and sun-protective clothing.

But what if consumers want a similar means to judge the protection of their eyes from the sun's damaging ultraviolet radiation (UVR)? There has not been an SPF for eyewear, even though there is clear evidence that UVR can cause significant short- and long-term ocular damage.

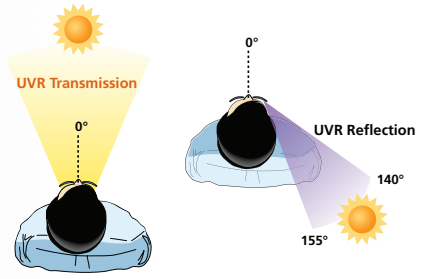
All high-index lens materials for clear, photochromic, and tinted lenses, as well as polarized sun lenses, provide at least some level of protection by preventing UVR from reaching the eye through the lens (blocking the *transmission* of UVR). However, most lenses do nothing to block the UVR that comes from the sides or is reflected directly into the eye by the back surface of the lens (Figure 1). Studies show that this indirect UVR may be a major factor in causing UVR-associated eye damage.

Sources of UVR

Much of the solar UVR that reaches the eye does not come directly from the sun. Rather, solar UVR can be scattered by clouds or reflected off objects, buildings, and the ground. In addition, UVR can be reflected by the back surfaces of sun and everyday lenses. A significant portion of this reflected UVR will reach the cornea, sclera, and periocular epidermis.

This reflected UVR has grown in importance because the No-Glare technology that is often applied to the back surface of spectacle lenses (both clear and sun lenses) reflects a surprising amount of UVR. Recent work by Karl Citek, OD, PhD, has found that, although No-Glare lenses can transmit 99% of *visible* light, these lenses can reflect up to 50% of the incident UVR.[1]

The result is that, until the development of the current generation of Crizal® lenses, lenses treated with No-Glare technology could *reflect* UVR onto the cornea, sclera, and delicate periocular skin—even if the lens blocked 100% of UVR transmission. Of course, lenses without No-Glare technology can also reflect some amount of UVR into the eye.



UVR transmitted through the lens when the sun is in front of the wearer

UVR reflected from the back of the lens when the sun is not in front of the wearer

Figure 1 UVR can reach the eye either by transmission through the lens or reflection from the backside of the lens. E-SPF takes into account both sources of UVR. (Note: maximum reflection occurs when the UVR source is at 140° to 155°.)

Table 1
E-SPF of Different No-Glare Lenses

No-Glare Lens	E-SPF
Crizal Avancé UV™*	25
Competitor A	≤ 3
Competitor B	5
Competitor C	5

*with clear 1.5 index plastic, E-SPF of 10.

How E-SPF is Calculated

$$\text{E-SPF} = \frac{Irradiance^{\text{No Lens}}}{Irradiance^{\text{Lens}}} \approx \frac{1}{T_{UV}^{0°} + R_{UV}^{145°}} *$$

$T_{UV}^{0°}$ = amount of UVR transmitted with UVR source perpendicular to lens (0°).
$R_{UV}^{145°}$ = amount of UVR reflected with UVR source at 145°

* Direct eye exposure depends on external factors (eg, wearer's morphology, frame shape, position of wear, etc), which are not integrated into the E-SPF formula.

Blocking UVR Transmission is Not Enough

Until now, the only quantitative measures of UVR protection offered by everyday or sun lenses have been based solely on UVR transmission, a measure of the fraction of radiation that is blocked from traveling *through* the lens. While this is helpful, a complete measure of UVR protection would also account for UVR that enters the eye from around the lens or is reflected off the back surface of the lens.

The Eye-Sun Protection Factor™ (E-SPF™)

What we need is a system with the elegant simplicity and complete public acceptance of the index used to rate skin care and sunscreen products' efficiency. With that in mind, Essilor scientists, in conjunction with an independent third party expert, have created the Eye-Sun Protection Factor (E-SPF) index.

E-SPF is defined as the ratio of UVR incident on the cornea (weighted to take in consideration the impact of UVR at different wavelengths) with and without lenses in place (see box). Higher values of E-SPF indicate greater levels of protection against UVR (Table 1).

With E-SPF, eyecare professionals and consumers will finally have a means to compare the levels of UVR protection provided by all kinds of eyewear, including clear, photochromic, and tinted/polarized lenses.

Reference

1. Citek K. Anti-reflective coatings reflect ultraviolet radiation. *Optometry*. 2008:79(3):143-8.