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

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

Why Do We Need An "Eye-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 index displayed prominently on the labels of 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 (UV) radiation? There has not been a similar index for eyewear, even though there is clear evidence that UV 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 UV from reaching the eye through the front of the lens (blocking the *transmission* of UV). However, most lenses do nothing to reduce the UV that comes from the sides or the back surface of the lens (Figure 1). Studies show that this indirect UV may be a major factor in causing UV-associated eye damage.

Sources of UV

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

This reflected UV has grown in importance because most No-Glare technologies reflect a surprising amount of UV off the back surface of the lens. 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 UV.[1]

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

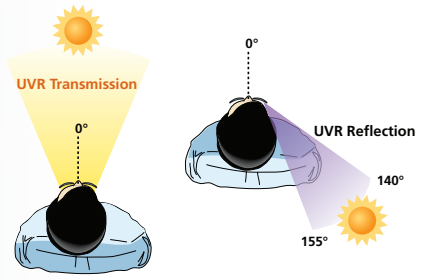
How E-SPF is Calculated

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

$T_{UV}^{0^\circ}$ = amount of UV transmitted with UV source perpendicular to lens (0°).
$R_{UV}^{145^\circ}$ = amount of UV reflected with UV 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. Note: maximum reflection occurs when the UV source is at 140° to 155°.

Blocking UV Transmission is Not Enough

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



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

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

Figure 1 UV 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 UV.

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, created the Eye-Sun Protection Factor (E-SPF®) index.

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

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

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

* E-SPF of 25 when *Crizal* is made with any lens material other than clear 1.5 plastic.

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