Part 66 of a series

What distributors should know about auto-darkening welding lenses

Although auto-darkening lenses have been in use for more than ten years, nagging doubts among welders concerning their effectiveness and safety persist. A look at the developing and existing standards for these lenses will give the distributor salesmen a solid background for promoting the full acceptance of this technology

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Both conventional welding lenses and auto-darkening lenses must meet certain criteria if they are to provide optimum eye and face protection for welders.

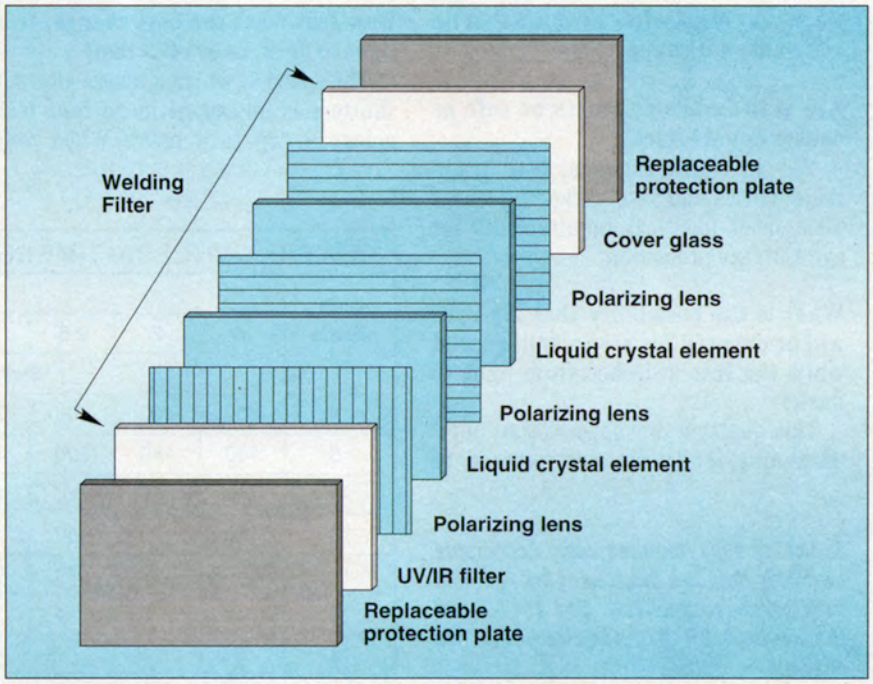
Currently, both the American National Standards Institute (ANSI) and the Canadian Standards Association (CSA) are addressing the critical safety concerns that include protection from ultraviolet and infrared (UV/IR) radiation.

A review of the standards already adopted in Europe will offer some insight into what the U.S. and Canadian standards will look like when they are finally approved.

The beginning

The auto-darkening technology was first perfected in Europe where exhaustive studies were performed during the 1980s. Analyses and tests included:

- The possible health effects of millisecond-exposures to visible light that passes through automatic lenses during the darkening process.
- The length of time elapsed



A non-electric, UV/IR interference filter is independent of all the other layers in a typical auto-darkening lens. UV/IR protection is constant and unrelated to the light or dark state of the lens.

(switching time) required for the lens darkening process to take place.

- The light transmission characteristics of the lens for both its semi-transparent and dark states.
- The "fail-safe protection" provided against harmful light components during a sudden failure of the battery, lens circuitry, or the lens itself.

The European studies established the basis for the first published standard for automatic lenses: the 1987 West German standard, DIN 4647 Tiel 7.

The DIN standard was also the basis for the new European Community (CEN) standard, which recently reached its final draft form. The CSA subcommittee that is drafting the Canadian auto-darkening standard is closely reviewing the CEN standard. It appears likely that much of the CEN standard will be incorporated. Thus it is anticipated that there will be worldwide continuity among the various standards for auto-darkening lenses.

While the U.S. and Canadian specialized standards are being perfected, many lenses in the two countries have the DIN 4647 conformity label. Copies of these standards are readily available from the lens manufacturers adhering to them.

Distributors face a broadside of questions

Following are typical questions with which distributors are often confronted when they offer safety products that involve auto-darkening lenses.

Are auto-darkening lenses as safe as conventional lenses?

Yes. In North America, both traditional lenses and auto-darkening lenses must meet identical requirements for eye and face protection.

What is the possibility that my eyes will be exposed for even a split second while the lens switches from light to dark?

This question presupposes that auto-darkening lens-users are exposed to minute doses of the welding flash.

While it is true that the welding arc creates a spectrum of light that contains segments of harmful IV/IR (that can cause "arc-eye"), a nonelectronic optical filter, built into most auto-darkening lenses, continually blocks the UV/IR portions of the spectrum.

UV/IR filters are also available that permit only harmless, visible light (from the green/yellow portion of the spectrum) to pass through. This capability permits welders to view the work area at all times.

How do auto-darkening lenses work?

Automatic welding lenses contain three principal components.

- An UV/IR optical filter.
- One or more liquid crystal light shutters.
- Electronics that detect arc presence and control the liquid crystal shutters.

An auto-darkening lens contains photosensors that react to the light from the arc the instant it is struck. A signal generated actuates an electronic circuit that causes the liquid crystal shutters to change their alignment. As the shutter formation changes, the lens becomes darker to eliminate the bright, irritating, visible light portion of the light spectrum. As a result, a welder is always able to view the weld pool at a comfortable light level.

How fast must the lens change, from light to dark, to be effective?

The speed at which a lenses alters its shutters is important in current technology — up to a point. When auto-lenses were first introduced, some models had a slow response time and welders were subjected to conditions that resulted in fatigue. Most of these "slow lenses" have been withdrawn from the market.

In general, lens switching time should be less than five milliseconds (5/1000th second) for most welding applications. At this speed, the transition from no arc (semi-transparent lens) to arc present ("dark" lens) occurs fast enough to preclude any irritating light from reaching the eyes of the welder. Also, effective switching times vary according to the light state and the dark state of any given lens (Table 1.)

Switching times are currently covered by the German DIN standard and the revised British standard (BS 679) for auto-darkening lenses, and very likely will be included in the ANSI and CSA standards being developed.

The current selection criteria should be the DIN standard.

What happens if the power to the lens fails?

Different models compensate for sudden power or battery failures in different ways. (The developing standards should address this issue.)

Most lenses incorporate a static optical filter that protects welders against exposure to UV/IR. This filter is not tied into the electronics of the lens.

Are auto-darkening lenses effective with all arc welding?

Some auto-darkening lenses contain a sensitivity control that permits an adjustment for different types of arc. This

TABLE 1: SWITCHING TIME BETWEEN LIGHT AND DARK SHADES

Dark shade	Light shade						
	1.7	2	2.5	3	4	5	6
	Switching time in ms (max)						
7	300	400	500	700	1000	No requirement	No requirement
8	100	150	200	300	500	1000	No requirement
9	40	50	70	100	200	400	700
10	20	20	30	40	70	100	300
11	6	7	10	15	30	50	100
12	2	3	4	5	10	20	40
13	0.8	1	1.5	2	4	7	10

Switching time requirements. Acceptable switching time is a function of the light and dark shade, respectively. DIN 4647-7 and the revised BS 679 requirements are shown.

TABLE 2: LENS SHADE REQUIREMENTS

Shade Guide*

Welding Process	Arc Current (Amps)	Minimum Protective Shade	Suggested Protective Shade (Comfort)
Shielded Metal Arc Welding (SMAW)	Less than 60	7	—
	60 to 160	8	10
	160 to 250	10	12
	250 to 550	11	14
Gas Metal Arc Welding and Flux Cored (GMAW) (MIG)	Less than 60	7	—
	60 to 160	10	11
	160 to 250	10	12
	250 to 550	10	14
Gas Tungsten Arc Welding (GTAW) (TIG)	Less than 50	8	10
	50 to 150	8	12
	150 to 500	10	14
Arc Carbon (light)	Less than 500	10	12
Air Carbon (heavy)	500 to 1000	11	14
Plasma Arc Welding (PAW)	20 to 100	8	10
	100 to 400	10	12
	400 to 800	11	14
Plasma Arc Cutting (PAC)			
Light	Less than 300	8	9
Medium	300 to 400	9	12
Heavy	400 to 800	10	14
Carbon Arc Welding (CAW)	—	—	14

*Based on ANSI/ASC Z49.1, AWS F2.2-89. Shade numbers are given as guide only and may be varied to suit application needs. Consult your on-site training officer, industrial hygienist, or safety manager.

option permits auto-lenses to be adjusted for all types of arc welding, including low-amp TIG, inverter, and other low-pulsation processes that would otherwise "fool" lens photodetectors.

Sunlight can also fool some lenses. Under certain outdoor conditions, some lenses will flicker erratically between light and dark states during idle periods when the welder is not welding. Models that avoid this condition are available for outdoor work.

Distributor salesmen should work with the end-user to anticipate conditions under which he will operate before recommending a specific lens model and the options available.

How is the performance of one lens compared with that of another?

Extensive tests, performed by welders in the field, show that three critical performance criteria must be analyzed:

- Switching speed.
- Switching stability.
- Optical clarity.

A lens must have a good balance of all three of these characteristics to be acceptable to the welder.

When looking at switching speed, switching stability must also be considered. Stability is the ability of a lens to switch from dark to light or light to dark only when it is appropriate.

A "trigger-happy," or unstable lens, for example, can switch to "dark" (even when there is no weld arc present) when it is exposed to ambient light. Conversely, such a lens may switch to its light state when a welder's hand casts a shadow on it.

Lenses that are too sensitive and operate erratically create conditions that are very irritating. "Intelligent" lenses that respond only to arc presence avoid this condition.

Optical clarity varies greatly among welding lenses. Basically, the welder should never have to worry or even think about lens clarity. Poor lens clarity can result in shadowing, fluttering, halo-effects around the edges of the lens, and "image persistence." Image persistence, for example, occurs during stick welding when the shower of sparks persists as images in the lens (like tracers). This condition is distracting to the welder.

Automatic lenses with fast switching, highly intelligent stability, and excellent optical clarity are available from a number of manufacturers. Field testing and endorsements by satisfied users provide the best selection criteria, rather than the claims of a single supplier.

How fragile are automatic lenses?

Since automatic lenses can represent a substantial investment, welders, who must purchases their own safety equipment, become concerned about the ruggedness of these devices. Durability varies among various models. Some lenses require nothing more than customary care, while others are very fragile.

One way to protect lenses is to recess them into the helmet worn by the welder. Inner and outer cover plates are also used to protect lenses. The durability of a pair of lenses installed in a helmet can be demonstrated by dropping the helmet to the floor from tabletop height or higher.

The darkened state of one shade 11 lens is not the same as another shade 11 lens. Why?

While all lenses conform to ANSI standards, two shade 11 lenses, from two different manufacturers, may vary in darkness from one to another. This is true for both conventional lenses and auto-darkening lenses.

When possible, a welder should be asked to compare the shade of the lens to which he is accustomed, with the shades above and below it; i.e., a welder accustomed to a shade 11 lens should "bracket" and try out a new automatic lens in shades 10, 11, and 12.

Do I need a multiple-shade lens?

This answer depends on the variety of tasks a welder performs. Many welders perform the same type of welding consistently. In these cases, an auto-darkening lens with a "fixed dark shade" is fine. However, for welders who frequently change amperes and welding processes, a "multiple-shade lens" is more suitable. ***TWD***