

Arc Welding/Cutting Process	Base Metal	Shielding Gas	Arc Current in Amperes	Distance in m for 1 min	Distance in m for 10 min	Distance in m for 8 h
Shielded Metal Arc (Stick)	Mild steel	None	100–200	3.2	10	71
	Mild steel	CO <sub>2</sub>	90	0.95	3.0	21
			200	2.2	7.0	48
350			4.0	13	87	
GMAW	Mild steel	CO <sub>2</sub>	175	1.1	3.6	25
			350	2.3	7.3	51
			150	2.9	9.3	65
		95% Ar + 5% O <sub>2</sub>	350	6.7	21	150
			150	3.2	10	70
			300	5.0	16	110
	Al	Ar	150	1.6	5.0	34
			300	3.2	10	69
			50	0.32	1.0	6.9
	Mild steel	Ar	150	0.90	2.8	20
			300	1.7	5.5	38
			250	3.0	9.5	66
Al	Ar	50 AC	0.32	1.0	6.9	
		150 AC	0.85	2.7	19	
		250 AC	1.6	5.0	35	
PAW	Mild steel	He	150 AC	0.94	3.0	21
		Ar	200–260	1.5	4.9	34
		85% Ar + 15% H <sub>2</sub>	100–275	1.7	5.5	38
PAC (dry)	Mild steel	He	100	3.0	9.4	65
		65% Ar + 35% H <sub>2</sub>	400	1.4	4.4	31
PAC (H <sub>2</sub> O)	Mild steel	N <sub>2</sub>	1000	2.4	7.5	52
			300	3.3	10	72
			750	1.7	5.5	38

(a) These distances are approximate. To convert to feet, multiply the distance in meters by 3.3.

(b) The distances are based upon the worst-case exposure conditions; maximum UVR for exposure angle, arc gap, and electrode diameter.

(c) Invisible actinic UVR poses a potential hazard to cornea (called welder's flash) and skin (much like sunburn) and exposure is cumulative with each exposure over an 8-h workday per 24-h period.

(d) TLVs are published by the ACGIH, Cincinnati, Ohio.

(e) These distances were based upon data from Lyon, T. L. et al, 1976. *Evaluation of the Potential Hazards for Actinic Ultraviolet Radiation Generated by Electric Welding and Cutting Arcs*. U.S. Army Environmental Hygiene Agency.

## Exposure Effects

Since the beginning of arc welding, welders have known welding and cutting operations can cause acute effects such as severe "sunburn" (erythema) of the skin and painful "welder's flash" (photokeratitis) of the cornea of the eye. Consequently, early welders empirically selected protective clothing and eyewear for comfortable viewing. Also, the U.S. Army adopted a measure to prevent eye injuries in industrial areas. Ordinary safety glasses were prescribed for all Army personnel, including welders and their helpers. As a by-product of physical injury prevention, the eyewear resulted in a dramatic drop in the incidence of welder's flash. Any stray invisible actinic UVR was also blocked by the transparent lenses.

## Exposure Limits

The first actinic UVR exposure guidelines were published by the American Conference of Governmental Industrial Hygienists (ACGIH) in 1972 (Ref. 1). These guidelines were intended to pre-

vent the acute effects of actinic UVR. The International Non-Ionizing Radiation Committee (INIRC) of the International Radiation Protection Association (IRPA) (Ref. 2) proposed similar guidelines in 1985. After considerable review, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) (Ref. 3) revalidated and endorsed those limits. Besides being concerned about acute effects, these standards have also been shown to minimize any adverse effects and pose an extremely small risk for delayed effects.

## Instrumentation

By the early 1970s, several instruments were available to measure actinic UVR but many simpler instruments presented significant measurement errors primarily from a flaw called "stray light." The actinic UVR resulting in an acute injury followed a narrow range of wavelengths (from around 200–315 nm) with a varying "action spectrum" (peaking sharply at 270 nm). Producing an instrument with this wavelength response was difficult with known filters at that time. The better in-

struments were the traditional ultraviolet spectrometers that could manually scan UVR wavelengths, weigh the results against the exposure standard for each wavelength, then sum them for the net result.

## Joint Effort

In 1974, a joint effort was planned to determine the optical radiation hazards from electric arc welding and cutting operations. Testing was planned for six processes: gas tungsten arc welding (GTAW), gas metal arc welding (GMAW), flux cored arc welding (FCAW), plasma arc cutting (PAC), plasma arc welding (PAW), and shielded metal arc welding (SMAW). Organizations that provided personnel and equipment for the effort included Union Carbide Corp., the American Welding Society (AWS), Battelle Memorial Institute, National Institute of Occupational Safety and Health (NIOSH), and the U.S. Army Environmental Hygiene Agency (USAEHA, now U.S. Army Center for Health Promotion and Preventive Medicine [USACHPPM]).

It is important to understand the difference between reverse flow check valves and flashback arrestors.

**The Flashback Arrestor**  
Prevents the reverse flow of gases and flashback.

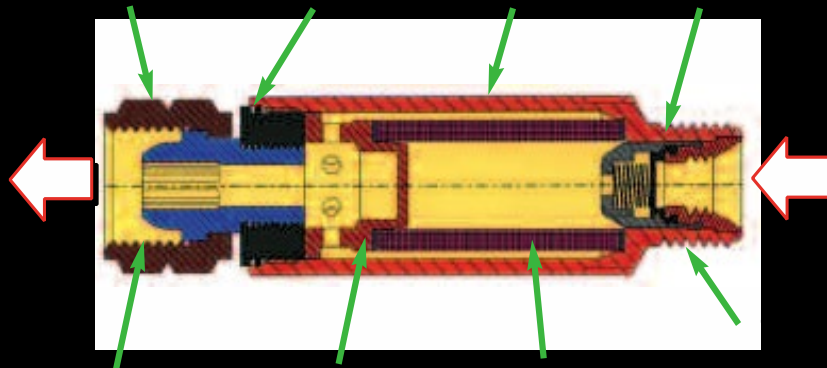


Illustration: FB-F Torch Model Shown