

UV and MR16 Lamps
 Adrienne Shulman, LC
 GE Specification Engineer

The Halogen MR16 lamp is one of the most commonly used lamps in museums and homes for lighting art. It has a small profile and gives a nice warm glow with good color quality. But many ask the same question: What is the UV transmission of Halogen MR16 lamps with and without cover glass? What are its risks? Is a separate filter required to cut back enough UV as to not damage the art?

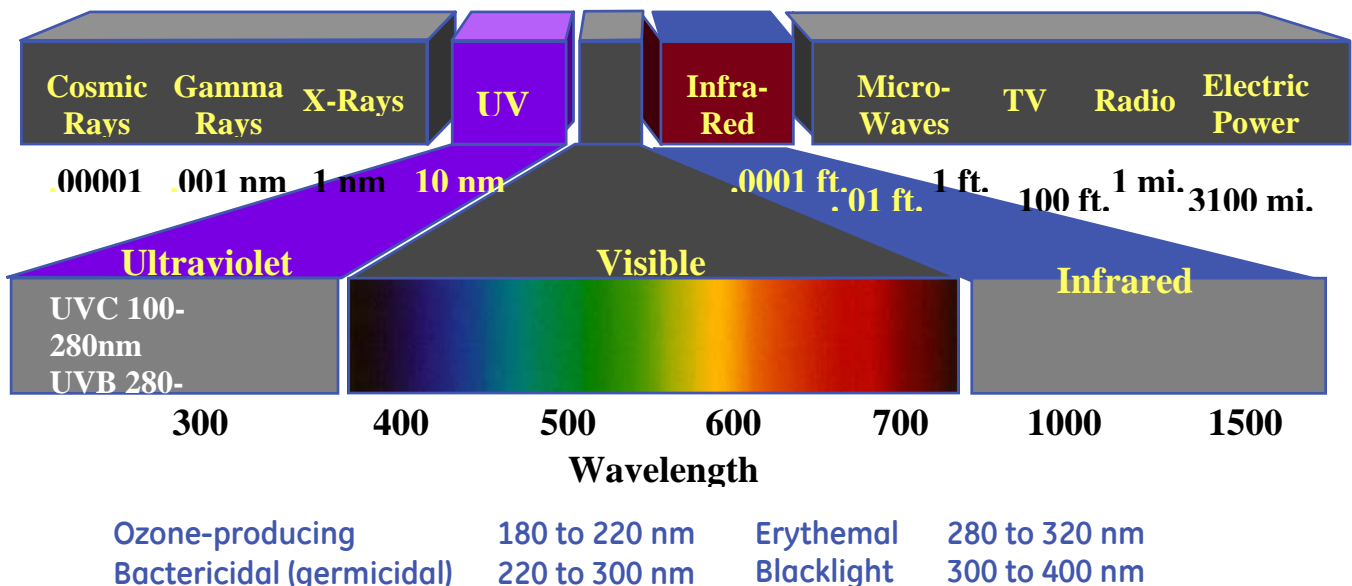
The Glossary of Terms in the GE lamp catalog defines **Ultraviolet (UV) Radiation** as:

For practical purposes, any radiant energy within the range of 100-380 nanometers. It is beyond the blue or violet region of the spectrum, and is invisible to the eye just like the silent "ultrasound" dog whistle is inaudible to the ear.

*UV is divided into 3 regions:
 UVA – 100 to 280 nm
 UVB – 280 to 315 nm
 UVC – 315 to 400 nm*

Some wavelengths (180-220) produce ozone, some (220-300) are bactericidal, some (280-320) erythematous (redden human skin); others (320-400) cause secondary luminance (black light).

Electromagnetic Spectrum



- Lighting an object involves the narrow band of wavelengths from approximately 400 -770 nanometers.
- Light is always accompanied by some amount of Infrared (IR) and Ultraviolet (UV).
- Light contributes to vision and damage.
- Non-visible IR and UV contribute to damage, but not to vision.

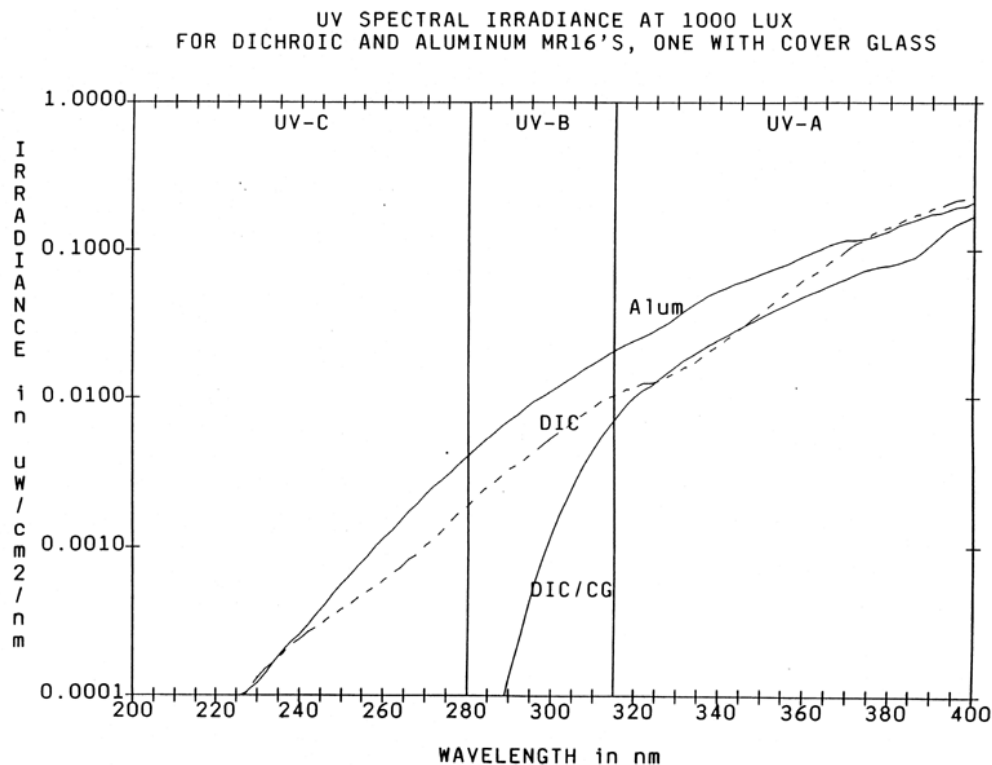
How is UV output of lamps measured?

Spectroradiometer – designed to measure the spectral power distribution of illumination. It measures watts of UV output as a function of wavelength (nm) - to better compare light sources, calculate total watts of UV generated per lumen of visible light or microwatts (.000001 watts) per lumen.

Some typical values – microwatts/lumen:

Incandescent	75	1.7%
Halogen PAR38	67	1.4%
Halogen MR16, Dichroic, glass cover	36	0.9%
Halogen MR16, aluminized, glass cover	95	1.9%
Fluorescent	130	3.4%
Daylight + glass	275	6.7%
Metal halide	350	9.0%

The percentage represents the ratio of UV to the combined UV and visible light. To quote the paper (Light Sources and Dye Fading): *The UV% is the ratio of UV (300-400nm) to the flat-weighted emission between 300-700nm (UV + visible). At less than about 2% UV to total of UV + visible emission, filtering UV is of little value when visible light is controlled.*

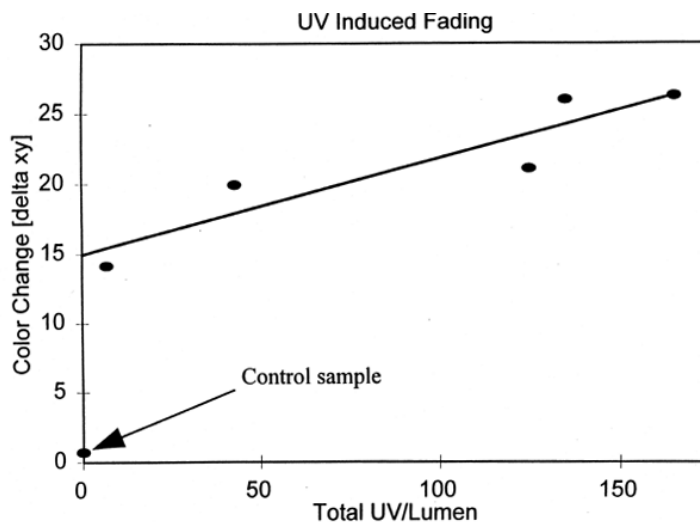


The above chart compares UV in a dichroic and aluminum MR16 and a dichroic MR16 with cover glass. Aluminized reflectors with no cover glass contribute more UV than dichroic-coated reflectors. The reason is that dichroic films do not reflect at UV wavelengths - rather, they absorb most of the UV and transmit an additional small proportion. When compared to MR-16 lamps made with aluminized reflectors there is a clear advantage for the dichroic versions.

The cover glass on the MR16 eliminates much of the UVB and all UVC. All GE Constant Color MR16 general lighting lamps now use a doped quartz capsule, which eliminates even more UV than shown in the above chart (See Figure 9 below) and reduces the UV below any required safety level. In addition any MR16 lamp with a cover glass also meets the UV safety requirements (even if non doped quartz were to be used.) An IR coating also brings the UV to a safe level.

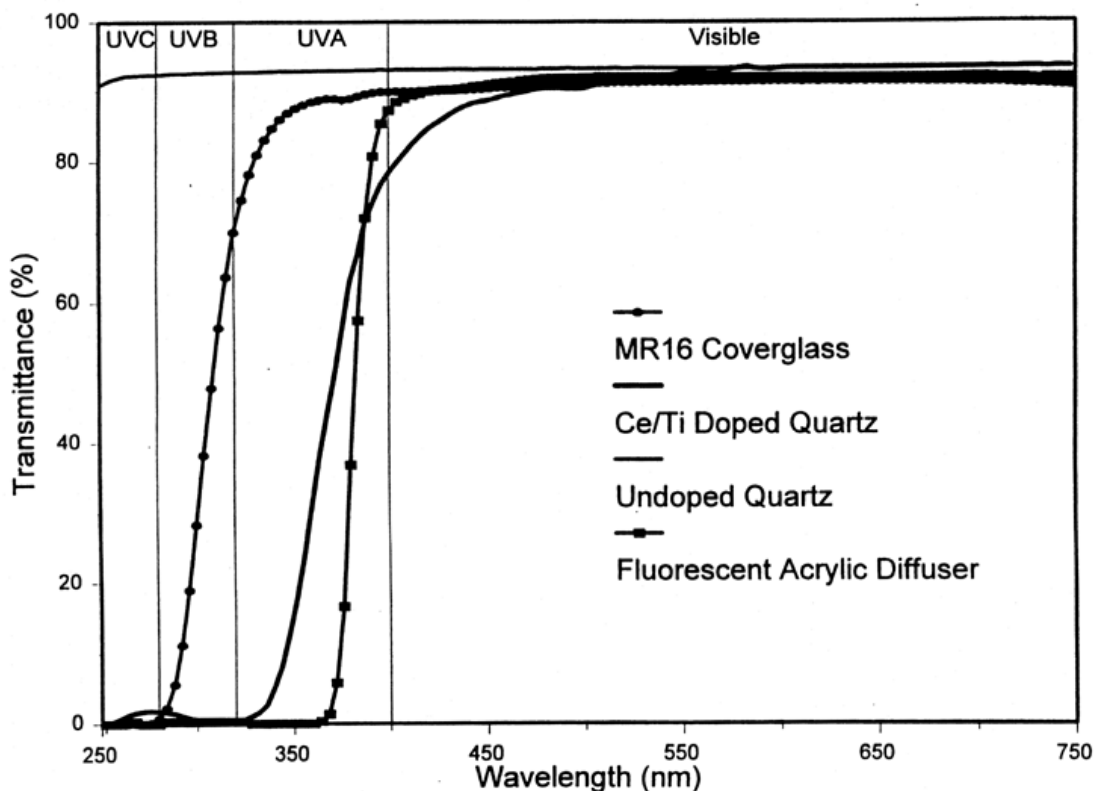
There's much more than just the minimal UV from MR16 lamps and other Halogen sources to take into account when lighting art. For conservation purposes, the single most important consideration is the strict control of the cumulative exposure to visible light energy - the product of visible light intensity and time. Ultraviolet light, humidity and temperature normally cause secondary and nearly insignificant effects by comparison. Exposure time as well as foot-candle levels are both paramount to illuminating art properly for conservation. The IESNA recommendations explicitly recognize the reciprocal relationship of intensity and time of exposure so that proper lighting design choices may be made. See the IES Lighting Handbook for further art lighting recommendations.

UV causes fading - but so does visible light!



On the above graph, the control sample is in darkness. When all the UV is filtered out of a light source, there is still 15 "points" of color change. More UV content accelerates fading, but eliminating only UV is not necessarily an adequate protective measure for light sensitive materials.

Figure 9



Even a simple prismatic lens on a fluorescent fixture cuts out a significant amount of UV.

Reduce Ultraviolet with:

- Acrylic or polycarbonate filters
- UV absorbing glass
- Dichroic glass filter
- Sleeved fluorescent lamp - CovRGuard
- Doped halogen quartz capsules
- Indirect lighting (non-UV reflecting surfaces)
- Multi-layer films on capsules, reflectors
- HIR, Precise

There is currently an ANSI and IESNA Standard entitled **Photobiological Safety for Lamps - Risk Group Classification and Labeling**. Within this standard Permissible Exposure Time (PET) is established for a lamp based upon a weighting of the spectral distribution of the lamp by the effectiveness of light at various wavelengths to produce damage to the eyes or the skin.

Permissible Exposure Time (PET) in hours @ 50 fc:

Light Source Type	PET (hours)
Sun, at 30 degrees from zenith (near noon at 40 N. latitude)	0.2
Sun, a 60 degrees from zenith (~5:00 PM in summer)	0.6
Sun, at 80 degrees from zenith (10 degrees above horizon)	~8.
Incandescent & Halogen Incandescent Lamps	
MR16 50W halogen lamp, without cover glass	18
MR16 50W halogen lamp, with cover glass	600
120V/500W Linear Quartz Halogen	4.6
120V/350W Linear Quartz Halogen-IR™	540
PAR38 120W Incandescent	250
PAR38 90W Glass Halogen	720
PAR38 60W Quartz Halogen-IR	5000
Fluorescent Lamps	
F40T12CW fluorescent	16
F32T8SP41 (made in US)	30
F32T8SP41 (made in UK)	108
F32T8SP41 (made in US) with acrylic diffuser	2000
High Intensity Discharge (HID) Lamps	
400W Mercury	72
400W Metal Halide	260
400 High Pressure Sodium (HPS)	6800

As you can see, sunlight has the shortest Permissible Exposure Time. Sunlight is far more damaging than most electric light sources. One FDA study shows 8 hours exposure to fluorescent lighting is about the same as 72 seconds of sunshine in Washington, D.C. in July! Indirect daylight is less damaging, especially if reflected from UV-absorbing materials or finishes, such as zinc oxide or titanium dioxide based paints.

Virtually all general lighting lamps emit some UV during normal operation, but the amounts are well below those found in natural daylight and sunlight or even daylight and sunlight filtered through normal window glass. UV emissions from commonly used general lighting lamps are typically low enough that they would be classed as "exempt" under the new ANSI standard.

Halogen MR16 lamps provide excellent point source capabilities for museum lighting applications. IR reflecting films on capsules increase efficacy, reduce UV and heat content in the beam. Dichroic coatings on reflectors reduce heat by 75%. Doped quartz capsules reduce UV as well as cover glass and other translucent materials such as acrylic and polycarbonate. If lighting art with Halogen MR16 lamps, it's not a problem when done thoughtfully.

References:

A. James Henderson, Ph.D., P.E., Frank F. LaGiusa, FIES, Terry K. McGowan, FIES, (1990 IESNA Annual Conference), *Light Sources and Dye Fading*, GE Lighting, NELA Park.

ANSI/IESNA RP-27.3-96 - *Photobiological Safety for Lamps - Risk Group Classification and Labeling*.

ANSI/IESNA RP-30-96 - *Museum and Art Gallery Lighting: A Recommended Practice*.

GE Lamps 2008-2009 Product Catalog

GE Lighting Institute - (December 22, 2004, Revised January 23, 2001), *Technical Tidbits®: Ultraviolet Emission From General Lighting Lamps*.

Gotti, Mary Beth, (1999), *Light Sources and Dye Fading*, PowerPoint presentation GE Lighting, NELA Park.