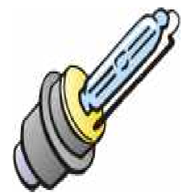
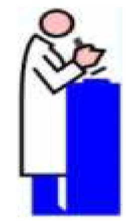
University of California, Irvine
Environmental Health & Safety Office
Radiation Safety Division





ULTRAVIOLET LAMP SAFETY FACTSHEET

Ultraviolet (UV) lamps are used on the UC Irvine campus in a variety of applications. They are found in germicidal lamps, “black lights”, mercury vapor lamps, solar simulators, photochemical curing equipment, metal halide lamps, etc.

The UV radiation portion of the electromagnetic spectrum lies approximately between 100 nm and 400 nm in wavelength. *[Note: 1 nm = 1 nanometer = one billionth of a meter.]* The UV spectrum has been subdivided into three distinct spectral bands:

- **UV-A radiation** (315 nm to 400 nm), which is called “near UV” and "black light", is the least photobiologically-active, but exposure can produce tanning and some burning of the skin, and can lead to the formation of cataracts (opacities in the lens of the eye). It is efficiently transmitted by air and common glass. *[Tanning parlors generally expose patrons to UV-A radiation.]*

- **UV-B radiation** (280 nm to 315 nm), which is called “middle UV” and "erythemal UV", causes skin tanning and “sunburn”, photokeratitis (inflammation of the cornea of the eye), photoconjuctivitis (inflammation of the mucus membrane which lines the inner surface of the eyelids), and cataracts. It is transmitted by air, but can be blocked with common glass.

- **UV-C radiation** (100 nm to 280 nm), which is called “far UV” and "germicidal UV", also causes photokeratitis and photoconjunctivitis, with maximum effects occurring at 270 nm. It is blocked by common glass and by air (for wavelengths < 200 nm).

Due to the insidious onset of symptoms, exposed persons often do not realize the hazard attendant to exposure to UV radiation until the damage has occurred (sensations of pain do not occur initially). For example, persons who get sunburned at the beach often do not comprehend their predicament until they arrive home and get into the shower!

In addition to presenting significant eye and skin hazards, UV irradiation of the air (and of airborne substances) can lead to the generation of ***toxic compounds*** to which nearby personnel can be exposed. UV radiation at wavelengths below 250 nm can produce ozone and nitrogen oxides, and can convert chlorinated hydrocarbons, if present, into phosgene and hydrogen chloride. **In some instances, the risks from exposure to toxic gases are more substantial than the risks from exposure to the UV radiation itself**, due to the incorporation of optical safeguards into the UV generating system, and the absence of adequate ventilation in the area of the UV source.

Ultraviolet lamp safety guidelines

Principal Investigators (PIs) on campus must ensure that individuals who will be using UV sources under their supervision are adequately trained in the hazards related to these sources, and in the safe methods of using the equipment. This is especially true in cases in which UV-B and UV-C sources are to be used. PIs must supply protective equipment to all potentially exposed staff members when such equipment is deemed necessary and appropriate.

Carefully study the manuals supplied by the manufacturer of the UV-generating equipment used, and do not deviate from the instructions concerning its safe operation without first contacting the manufacturer. These manuals provide specific safety-related information (such as the type of eye/skin protection needed, ventilation requirements, etc.) that must be completely understood prior to energizing the equipment. If there is any confusion at all regarding the safe use of UV-generating equipment, it is essential that the manufacturer be contacted to clarify any concerns that you might have. If you are still uncertain about these issues, contact EH&S at 949-824-6098.

Serious and painful eye and skin injuries can result if UV lamps are used improperly. Therefore, only ***authorized and trained personnel*** familiar with the potential hazards and control measures may use such units. UV lamps must be used in designated areas with limited access, which affords protection to passers-by. Operation from within a closed, well-ventilated room or a draped area reduces the risks of exposure.

Whenever possible, UV lamps should be used under totally enclosed, interlocked conditions. Interlocks must not be intentionally defeated unless the attendant hazards are otherwise well controlled!

Needless exposures should be avoided, even in cases in which the eyes and skin are covered. **The UV lamp should never be viewed directly.** Take all necessary steps to reduce the exposure time to as short as is reasonably achievable, and use barriers/enclosures/shields to their maximum advantage.

Although the inverse square law applies to non-laser beam UV radiation, it is not advisable to look directly at any UV source (such as an arc or lamp) regardless of your distance from it.

Since ***maintenance and janitorial personnel*** may be accidentally exposed to the radiation from UV lamps while in the course of their duties, it is essential that all UV sources and facilities be adequately labeled to instruct such personnel of the danger of exposure (in some cases, these warnings should be in both English and Spanish; ***Danger – Ultraviolet Radiation ⇨ Peligro -- Radiación Ultravioleta***). **Ideally, all activated UV sources should either be attended by knowledgeable personnel at all times, or the lamps should be housed in foolproof, interlocked enclosures.** However, warning signs are needed in both cases. Prominent activation warning lights are also helpful.

Protective Eyewear, Clothing and Skin-protective Agents

Operators of UV-generating equipment for which the radiation is not totally enclosed and exposures are possible must wear UV-filtering face shields, long-sleeved shirts, gloves, and sometimes long pants. Although these items may not completely eliminate the exposure to UV radiation, they reduce the risk of a severe burn substantially. UV-filtering glasses with side shields will occasionally suffice for very short-term exposures when the radiation is not considered to be of sufficient intensity to cause skin effects; *this can be a risky venture, though.* Most UV-filtering face shields and spectacles are made of ***polycarbonate*** plastic, which is capable of absorbing 99% of UV radiation up to 400 nm (violet light).

For UV radiation generated from **welding operations**, the most effective control for protecting the eyes is the use of a proper welding helmet containing darkened UV-filtering lenses. The skin must similarly be protected by the wearing of appropriate clothing and gloves (see below). Nearby personnel can be protected by using welding curtains/screens that physically block the UV radiation. Welding booths must be adequately ventilated to protect the welder (and others) from any potentially hazardous fumes, vapors and gases that may be released during welding and cutting operations.

The skin can be protected either by wearing appropriate clothing (the preferred method!) or by applying protective creams and ointments. Certain types of fabrics attenuate UV radiation well, while other types do not. Leather gloves, aprons and jackets have been successfully used for this purpose in welding, manufacturing and research applications involving UV exposure. Woven fabrics vary greatly in their attenuation properties. Obviously, loosely-woven fabrics through which one can readily see light when they are held up to a lamp will not be as effective as tightly-woven materials. Cotton fabrics generally have UV-B diffuse transmission values ranging from 5% to 30%, rayon and rayon blends transmit somewhat less (10% to 15%), and heavy wool and flannel materials may transmit 1% or less. Poplin has been reported to have very low UV transmittance. Nylon is very ineffective and may transmit up to 40% of the UV radiation. The attenuation can be greatly enhanced by the wearing of layered clothing.

A number of topical skin-protective agents have been developed which provide partial to total filtration of UV radiation. These agents include para-aminobenzoic acid (PABA) and its esters, salicylates and cyanamates. These preparations are generally placed into solution with substances that have good substantivity. Substantivity is a term used to indicate the affinity of a solution for absorption into and retention in the skin.

UV Exposure Standards

There are no Federal or State of California safety standards that specify permissible occupational exposure levels to UV radiation. For the most part, UV exposures are covered under the "General Duty Clause" that indicates that all workers must be protected from recognized hazards.

However, the American Conference of Governmental Industrial Hygienists has established UV exposure levels (called **Threshold Limit Values®**) to which it is believed that nearly all healthy workers may be exposed repeatedly without suffering erythema (sunburn) or photoconjunctivitis. The TLVs apply to exposures of the skin from arcs, gas and vapor discharges, fluorescent and incandescent light sources, and also solar radiation. *{They do not apply to exposure to coherent UV radiation generated by lasers, nor do they apply to extremely photosensitive individuals.}* The TLVs are intended to be used as guidelines for controlling exposures of personnel to continuous UV sources (exposure duration $\geq$ 0.1 sec).

The TLVs are provided in units of millijoules of energy per square centimeter of surface area (mJ/cm^2). They are presented as a function of wavelength from 180 nm up to 400 nm for ***wavelength-dependent exposure times*** that need to be calculated using a parameter termed the relative spectral irradiance. The TLV values indicate the following:

- ❖ The most hazardous UV radiation is that with wavelengths between 240 nm and 300 nm. In this wavelength range, the TLV is less than 10 mJ/cm^2, with the minimum TLV (the most hazardous radiation) being at 270 nm (TLV = 3 mJ/cm^2)

- ❖ The least hazardous UV radiation is that with wavelengths exceeding about 315 nm (UV-A radiation). Above that wavelength, the TLV is always over 1000 mJ/cm^2, and it steadily climbs above that wavelength indicating that the radiation is less hazardous with increasing wavelength.

- ❖ Between 180 nm and 240 nm, the radiation becomes increasingly more hazardous.

A few additional notes obtained from the 2003 TLV booklet:

1) The probability of developing skin cancer from UV exposure is related to a variety of factors such as skin pigmentation (persons with light skin are at the greatest risk), a history of blistering sunburns, and lifetime accumulated UV dose.

2) Some topical preparations and systemic chemicals can heighten the risk of exposure to UV radiation. Examples of these are some antibiotics (e.g., tetracycline and doxycycline), as well as some antidepressants, diuretics, cosmetics, antipsychotic drugs, dyes, etc. Always be cognizant of this possibility and read prescription/product labels or consult with your pharmacist regarding this matter.

3) Outdoor workers in latitudes within 40 degrees of the equator can be exposed to quantities of UV radiation which exceed the TLV in as little as *5 minutes* around noon during the summer months!!!

☎ If you have any questions concerning the safe use of UV-generating equipment, please contact EH&S Radiation Safety at 949-824-6200. ☎