America Biological Safety Association (ABSA)
Position Paper on the
Use of Ultraviolet Lights in Biological Safety Cabinets

Purpose: The purpose of this paper is to set forth the American Biological Safety Association's position and recommendations regarding the use, risk and benefits of using ultraviolet radiation in Biological Safety Cabinets.

Background:

Ultraviolet (UV) radiation is a form of nonionizing radiation and behaves in accordance to the laws and principles of geometric optics. Electromagnetic radiation can be described as a "wave" that consists of an electric field and a magnetic field. Electromagnetic radiation is usually characterized by wavelength, frequency and/or photon energy. The term wavelength refers to a distance in a line of advance of a wave from any point to a like point on the next wave; it corresponds to the distance traveled by the wave during one cycle. A wavelength is usually measured in angstroms or nanometers (nm)**.**

The International Commission on Illumination (CIE)(1) divided the UV spectrum into three wavelength bands primarily due to biological effects. The 315-400 nm wavelength band is designated as UV-A. 280-315 nm is designated as UV-B, and 100-218 nm as UV-C. Wavelengths below 180 nm are of little practical biological significance since the atmosphere readily absorbs them. Sources of UV-A are used for dentistry and tanning, UV-B is used for fade testing and photocuring of plastics, and UV-C is used for germicidal purposes. All wavelengths less than 320 nm are actinic meaning they are capable of causing chemical reactions.

Effects of Overexposure to Humans

Biological effects from UV radiation vary with wavelength, exposure level, and duration of exposure. In general, adverse effects are limited to the skin and eyes. Erythema (e.g. reddening of the skin in sunburn) is the most commonly observed effect on the skin. Erythema is a photochemical response to the skin normally resulting from overexposure to wavelengths in the UV-C and UV-B bands. Exposure to UV-A alone can produce erythema, but only at very high radiant exposures. Chronic exposure to UV radiation may accelerate the skin aging process and increase the risk of developing skin cancer.

Elevated exposure of UV-B and UV-C radiation may adversely affect the eye and cause photokeratitis and/or conjunctivitis. A sensation of "sand in the eyes" and reddening of facial skin usually occurs within 6-12 hours of the exposure, with the symptoms and discomfort lasting up to 48 hours. UV radiation exposure rarely results in permanent ocular injury, although cataracts have been produced in animals by exposure to UV radiation in the UV-B and UV-A bands.

UV radiation exposure to eyes and skin is typically quantified in terms of an irradiance E (Watts/meter^2) for continuous exposure, or in terms of a radiation exposure H (Joules/meter^2) for time-limited exposure.

Regulations and Guidelines

The Occupational Safety and Health Administration (OSHA) does not have a permissible exposure limit for UV radiation. Guidelines on UV radiation exposure have been established by the International Radiation Protection Association (IRPA) and adopted by the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH does have a threshold limit value (TLV) table for UV radiation and relative spectral effectiveness, which is published in the Threshold Limit Values (TLV) booklet(2) annually.

Using the current guidelines, it is expected that repeated exposure at or below the current guideline will not cause adverse health effects. These values apply to all UV radiation sources except UV lasers. These values do not apply to UV radiation exposure of photosensitive individuals or individuals concomitantly exposed to photosensitizing agents. It should be emphasized that many individuals who are exposure to photosensitizing agents (ingested or topically applied chemicals) probably will not be aware of their heightened sensitivity.

Boettrich(4) performed a study evaluating UV light exposure from six biological safety cabinets(2). Permissible exposure times using a research radiometer photometer equipped with a UV actinic band sensor were evaluated and could be established within:

1. Thirty-two minutes to 1.4 hours at general eye level in the center of the room.
2. Thirteen to 24 minutes for eye level exposures while seated at the cabinet.
3. Twenty-eight to 44 seconds for hand level exposures at the cabinet face.

Boettrich(4) also evaluated potential exposures around biological safety cabinets with 253.7 nm UV bulbs. Overexposures at the face of the cabinets could occur within 1.3-6.7 minutes.

Germicidal Benefits of UV Light in Biological Safety Cabinets

The Centers for Disease Control (CDC) and the National Institute of Health (NIH) agree that UV lamps are not recommended nor required in biological safety cabinets (5).

The activity of UV lights for sterilization/decontamination purposes is limited by a number of factors including(7):

- <u>Penetration</u> - In a dynamic air stream (e.g. biological safety cabinet): UV light is not penetrating. Microorganisms beneath dust particles or beneath the work surface are not affected by the UV irradiation. UV irradiation can cause erythema that may damage both the skin and eyes of laboratory. Eyes and skin are primarily involved because UV does not penetrate deeply into tissue. These effects are generally not permanent but can be quite painful.

- <u>Relative</u> <u>Humidity</u> - Humidity adversely affects the effectiveness of UV. Above 70% relatively humidity, the germicidal effects drops off precipitously

- <u>Temperature and Air Movement</u> - Optimum temperature for output is 77-80°F. Temperatures below this optimum temperature result in reduced output of the germicidal wavelength. Moving air tends to cool the lamp below its optimum operating temperature and therefore results in reduced output.

- Cleanliness - UV lights should be cleaned weekly with an alcohol and water mixture as dust and dirt can block the germicidal effectiveness of the ultraviolet lights.

- Age – UV lamps should be checked periodically (approximately every six months) to ensure the appropriate intensity of UV light is being emitted for germicidal activity (UV C). The amount of germicidal wavelength light emitted from these bulbs decreases with age and bulb ratings (hours of use) may vary by manufacturer.

Performance Standards for UV Light in Biological Safety Cabinets

The Center for Disease Control (CDC) and the National Institute of Health (NIH) agree that UV lamps are not recommended nor required in Biological Safety Cabinets (BSC)(5). The National Sanitation Foundation (NSF) Standard 49(6), the industry testing standard for all biohazard cabinetry, does not provide any performance criteria for UV lighting and specifically states in section 4.24.2 “UV lighting is not recommended in class II (laminar flow) biohazard cabinetry.”

As it is possible to produce ozone levels from UV wavelengths below 250 nm sufficient to affect rubber or other polymer made materials, low or no ozone UV lightbulbs are commercially available.

Recommendations

Due to the short time for UV overexposure to occur, it is recommended that neither laboratory nor maintenance personnel work in a room where UV lights are on(3). The CDC, NIH and NSF agree that UV lamps are neither recommended nor required in Biological Safety Cabinets (BSC). Criteria is not even available from NSF to evaluate the performance of the UV lights within a biological safety cabinet. Numerous factors affect the activity of the germicidal effect of UV light, which require regular cleaning, maintenance and monitoring to ensure germicidal activity.

Retrofitting any equipment (e.g. UV lights) into a biological safety cabinet may alter the air flow characteristics of the cabinet and invalidate any manufacturer warranty and is not recommended.

It is the current opinion of the American Biological Safety Association that UV lights are not recommended for use in Biological Safety Cabinetry.

Approved December 2000.

References

1. Personal Dosimetry of UV Radiation Publication CIE 98-1992; http://www.hike.te.chiba-u.ac.jp/ikeda/CIE/home.html.

2. 2000 TLVs and BEIs: American Conference of Governmental Industrial Hygienists: Threshold Limit Values for Chemical Substances and Physical Agents and Biologic Exposure Indices. ACGIH Worldwide, Cincinnati, OH (2000).

3. Ultraviolet Radiation Exposures in Biomedical Research Laboratories, Mark L. Noll. Appl. Occup. Environ. Hyg. 10(12) December, 1995, pp. 969-972.

4. Boettrich, E.P.: "Hazards Associated with Ultraviolet Radiation in Academic and Clinical Laboratories." Paper presented at the American Industrial Hygiene Conference, Orlando , FL, May 13-18, 1990.

5. Primary Containment for Biohazards: Selection, Installation and Use of Biological Safety Cabinets, U.S. Department of Health and Human Services, Public Health Services, CDC, and NIH, September 1995. US Government Printing Office Washington, 1995.

6. NSF International (NSF) Standard 49: Class II (Laminar Flow) Biohazard Cabinetry, The NSF Joint Committee on Biohazard Cabinetry, May 1992.

7. Keene, Jack; Certification and Use of Biosafety Cabinets (BSC's) © 1999 Biohaztec Associates, Inc., Midlothian, VA.