



# COLUMBIA UNIVERSITY

## HEALTH SCIENCES DIVISION

ENVIRONMENTAL HEALTH & SAFETY

### Working Safely with Ultraviolet Radiation

#### Policy and Procedures

**Purpose:** To provide information and guidelines for the safe use of Ultraviolet Radiation (UV) to protect the health of personnel using or potentially exposed during their work activities.

**Scope:** This policy covers all research laboratories as well as other areas at Columbia University Medical Center (CUMC) where Ultraviolet Radiation is used including research or germicidal purposes.

#### Procedures

##### Introduction

Ultraviolet radiation is widely used for killing bacteria or producing fluorescence. At CUMC several types of ultraviolet radiation emitting equipments are used in research laboratories. Employees using such equipment or working in the area may be potentially exposed to such radiation resulting in adverse health effects.

##### Types of UV Radiation:

UV radiation is divided into three distinct bands UV-A, UV-B and UV-C. Each has different penetration properties and potential for damage. The adverse health effects that may occur are erythema (sunburn), photokeratitis (a feeling of sand in the eyes), retinal burns, cataracts, melanoma and skin cancer.

Band	Wavelength	Primary Visual Hazard	Other Visual Hazards	Other Hazards
UV-A	315-400nm	cataracts of lens		skin cancer, retinal burns
UV-B	280-315nm	corneal injuries	cataracts of lens, photokeratitis	erythema, skin cancer
UV-C	100-280nm	corneal injuries	photokeratitis	erythema, skin cancer

##### Hazards

The biological effects of UV radiation depend on the wavelengths concerned. Sources emitting radiation with wavelengths longer than 200 nm are serious health hazards. Since UV radiation has such low penetrating power, the effects are confined mainly to the eyes and the skin.

The effects on skin are two types, acute and chronic. Acute effects appear within a few hours of exposure while chronic effects are long lasting, cumulative and may not appear for years. Acute effects of ultraviolet radiation are similar to sunburn; the redness of the skin called erythema. Chronic effects include accelerated skin aging and skin cancer.

The eye is very sensitive to UV where main effects are due to exposure to UV-B and UV-C, namely conjunctivitis and photokeratitis. In conjunctivitis the membranes lining the insides of the eyelids and covering the cornea become inflamed resulting in discomfort as if there was sand in the eyes. Photokeratitis manifests as an aversion to bright light. The severity of these conditions depends on the duration, intensity and wavelength of exposure. Symptoms may appear 6 to 12 hours after exposure and may subside after 24 to 36 hours with no permanent damage. Unlike the skin, the eyes do not develop a tolerance to repeated exposure to ultraviolet. The absorption of UV-A radiation in the lens of the eye is thought to produce progressive yellowing with time and may contribute to the formation of cataracts, causing partial or complete loss of transparency.

UV lamps often operate at pressures below or above atmospheric and may produce a risk of explosion particularly during lamp replacement or maintenance work.

### **Control Measures**

Protection against exposure may be achieved by a combination of engineering, administrative control measures and personal protective equipment. Emphasis should always be placed on engineering and administrative control measures to minimize the need for personal protective equipment.

Engineering control measures include enclosures, screens or filters used to contain the UV radiation or devices such as interlocks to allow safe temporary access to a hazardous area. Reflective surfaces should be avoided and surfaces should be painted in a dark, dull color.

Administrative controls consist of warning signs, limitation of access and exposure time and the provision of information on the nature of the hazard and the precautions to be taken. The PI should decide what measures are necessary to limit access to the source and to make personnel aware of its presence. It may be necessary to install warning signs and/or lights and to limit exposure time.

After these steps have been taken it should be determined whether it is necessary to provide protection for the face, eyes or skin and what type of Personal Protective Equipment (PPE) is needed. PPE may consist of gloves, laboratory coat, UV protecting goggles and or face shield.

### **Exposure Limits**

There is no Occupational Safety and Health Administration (OSHA) standard for exposure to ultraviolet light, but the National Institute for Occupational Safety and Health (NIOSH) recommends that the time of exposure to an intensity of 100 microwatts per square centimeter at wavelength 254 nanometers not exceed 1 minute. When averaged over an eight-hour work day, this value is 0.2 microwatts per square centimeter.

The American Conference of Governmental Industrial Hygienists (ACGIH) has issued Threshold Limit Values (TLVs) for occupational exposure to UV. These TLVs refer to ultraviolet radiation in the spectral region between 180 and 400 nm and represent conditions that nearly all workers may be repeatedly exposed without adverse health effects. The TLVs for occupational exposure to UV incident upon skin or eye are based on the irradiance and time of exposure. Broad band sources are weighted to determine the effective irradiance compared with the spectral effectiveness curve at 270 nm. Refer to current "Threshold Limit Values for Chemical Substances and Physical Agents" published by ACGIH for values.

Personnel must take adequate steps to shield themselves and in some cases limit the duration of exposure. Environmental Health and Safety (EH&S) office can provide assistance in measuring UV emissions and evaluating personal protective equipment.

It is also important to note that ozone is produced by sources emitting UV at wavelengths below 250 nm. Some UV devices may produce ozone in appreciable quantities and consideration should be given to monitoring exposure level.

**Wavelength range: 400 - 315 nm**

**i** Total irradiance on unprotected eyes and skin for periods of greater than 1000 seconds should not exceed  $10 \text{ Wm}^{-2}$ .

**ii** Total radiant exposure on unprotected eyes and skin for periods of less than 1000 seconds should not exceed  $104 \text{ Jm}^{-2}$ .

**Wavelength range: 315 - 200 nm**

The radiant exposure on unprotected eyes and skin within any 8 hour period is limited to values which depend on the wavelength of the radiation. For a broad band source the effective irradiance should be measured or calculated and the maximum permissible exposure determined from the table below.

Effective Irradiance ( $\text{Wm}^{-2}$ )	Maximum Permissible Exposure in an 8 hour period
0.001	8 hours
0.008	1 hour
0.05	10 minutes
0.5	1 minute
3	10 seconds
30	1 second
300	0.1 second

Measurements can be arranged by request to the EH&S.

**Instruments and Locations**

Below are several ultraviolet light generating devices, their use and where they are generally found within the University. Included in this list are recommendations for personal protective equipment and maintenance/monitoring.

**Transilluminator**

**Uses:** These are frequently used in research laboratories for visualizing nucleic acids following gel electrophoresis and ethidium bromide staining.

**General locations:** They are found in research labs throughout the Medical Center.

**Signage:** Access to rooms must be controlled by closing the door and posting a warning sign on the door stating the instrument is in use. The warning sign should include -Caution: High Intensity Ultraviolet Energy. Protect Skin and Eyes.

**Personal Protective Equipment:** Individuals working with the equipment must wear personal protective equipment while the transilluminator is operating. The PPE must protect the eyes and skin and include gloves, lab coat with no gap between the cuff and the glove, and a UV resistant face shield.

**Maintenance/ Monitoring:** Maintenance should be performed according to the manufacturer's instructions.

**Hand-held UV Units**

**Uses:** Frequently used in research laboratories for visualizing nucleic acids following gel electrophoresis and ethidium bromide staining as well as contamination survey.

**General Locations:** They can be found in research labs throughout the Medical Center.

**Signage:** Access to rooms must be controlled by closing the door and posting a warning sign on the door stating the instrument is in use. The warning sign should include - Caution: High Intensity Ultraviolet Energy. Protect Skin and Eyes.

**Personal Protective Equipment:** Individuals must wear personal protective equipment while the hand-held UV unit is operating. The PPE must protect the eyes and skin and includes gloves, lab coat with no gap between the cuff and the glove, and a UV resistant face shield.

**Maintenance/ Monitoring:** Maintenance should be performed according to the manufacturer's instructions.

### **Germicidal Lamps in Biosafety Cabinets**

**Uses:** These are used for disinfecting the interior surfaces of a biosafety cabinet prior to and after use. The germicidal properties of ultraviolet light are used in addition to routine chemical disinfection and must not be relied on as the sole method of disinfection.

**General Locations:** These lamps are found within the biosafety cabinet, above the work surface. Biosafety cabinets are primarily found in almost all biomedical research laboratories at the Medical Center.

**Signage:** Access to the interior of the biosafety cabinet while the lamp is operating is controlled by closing the sash. Some cabinets are equipped with an interlocking switch which deactivates the UV lamp when the fluorescent lamp is activated, however, personnel must ensure that the UV light is off prior to working at the cabinet. Placing labels that fluoresce when exposed to UV inside the biosafety cabinet should be considered if the UV lamp is not interlocked with the fluorescent lamp. The warning sign should include - Caution: High Intensity Ultraviolet Energy. Protect Skin and Eyes.

**Personal Protective Equipment:** The personal protective equipment must protect the eyes and skin and include gloves, lab coat with no gap between the cuff and the glove, and a UV resistant face shield.

**Maintenance/ Monitoring:** Since ultraviolet light is not used as a sole method of disinfection for the interior of biosafety cabinets, routine monitoring of the lamp's output is unnecessary. Bulbs should be wiped off on a monthly basis with a soft cloth dampened with ethanol. The bulb must not be operating and must be cool to the touch prior to wiping. Bulb replacement should proceed according to manufacturer's instructions based on the amount of use. Collect bulbs for disposal. Do not throw them in trash.

### **Germicidal Lamps in Clinical Areas**

**Uses:** These are installed at ceiling level in some clinical areas for air disinfection to control exposure to Mycobacterium tuberculosis. These lamps are used secondarily to ventilation controls such as directional airflow, dedicated exhaust and increased air exchanges per hour.

**General Locations:** Germicidal lamps have been installed for air disinfection in the Autopsy Suite.

**Access to room:** Access to the room does not need to be controlled while the lamps are operating. Room occupants are protected from exposure by the baffling portion of the light fixture.

**Signage:** Warning labels must be placed on the fixture stating Caution: High Intensity Ultraviolet Energy. Protect Skin and Eyes.

**Personal Protective Equipment:** Personal protective equipment is required only in situations when the baffle is removed and the lamp is operating. In those situations personal protective equipment would include skin and eye protection such as gloves, long sleeves with no gap between the cuff and the gloves, and a UV resistant face shield.

**Maintenance/Monitoring:** Since there are no guidelines indicating how much ultraviolet light output is required for air disinfection, routine monitoring to determine the lamp's efficacy is unnecessary. Bulbs should be wiped off on a monthly basis with a soft cloth dampened with ethanol. The bulb must not be operating and must be cool to the touch prior to wiping. Bulb replacement occurs annually. Baffled bulbs are monitored at that time for potential exposure.

### **Germicidal Lamps in Laboratories**

**Uses:** Germicidal lamps installed at ceiling level in some laboratories are used for air and surface disinfections. These lamps are used secondarily to ventilation controls such as directional airflow, dedicated exhaust, and increased air exchanges.

**General Locations:** Germicidal lamps have been installed for air and surface disinfection in some laboratories in the Medical Center such as in Building 722.

**Access to room:** Access to the room must be strictly controlled while the lamps are operating to prevent employee exposure. Many laboratories have a switch that is interlocked with the door. The UV lamp is only operational when the door is closed.

**Signage:** Laboratories having germicidal lamps without an interlocking switch must strictly control access to that area. Access can be controlled by installing an interlock switch such that the lamp is deactivated when the door is opened or by posting a warning sign on the door when the lamp is operating. The warning sign should include - Caution: High Intensity Ultraviolet Energy. Protect Skin and Eyes.

**Personal Protective Equipment:** Personnel must not enter area while the germicidal lamp is operating.

**Maintenance/Monitoring:** Since there is no guidelines indicating the how much ultraviolet light output is required for air disinfection, routine monitoring to determine the lamp's efficacy is unnecessary. The efficacy of surface disinfection via a ceiling mounted UV lamp is unreliable. Surface disinfection must be conducted with a chemical disinfectant specific for the organism in question. Bulbs should be wiped off on a monthly basis with a soft cloth dampened with ethanol. The bulb must not be operating and must be cool to the touch prior to wiping. Bulb replacement occurs annually.

### **Responsibilities:**

The Principal Investigator (PI) or Lab Safety Manager (LSM) is responsible to ensure that employees working with UV producing equipment are properly trained about the safe use of equipment, have access to appropriate PPE and don it when working with it. New personnel should be provided with a copy of this policy and fully explained about the safe use of UV emitting equipment prior to start of work.

EH&S will provide technical support necessary for the safe use of UV radiation.

### **References:**

OSHA, NIOSH, ACGIH, U.of Rochester