ULTRAVIOLET RADIATION IN THE WORKPLACE

1. INTRODUCTION

What is ultraviolet radiation?

Ultraviolet (UV) radiation is a form of electromagnetic radiation, like radio waves, x-rays and light. It is also sometimes called "ultraviolet light". On the electromagnetic spectrum, UV radiation comes between visible light and x-rays. That is, its wavelengths are shorter than the wavelengths of light and longer than those of x-rays. It is divided according to its effects on living tissue into three wavelength bands: UV-A, UV-B and UV-C (see Figure 1).

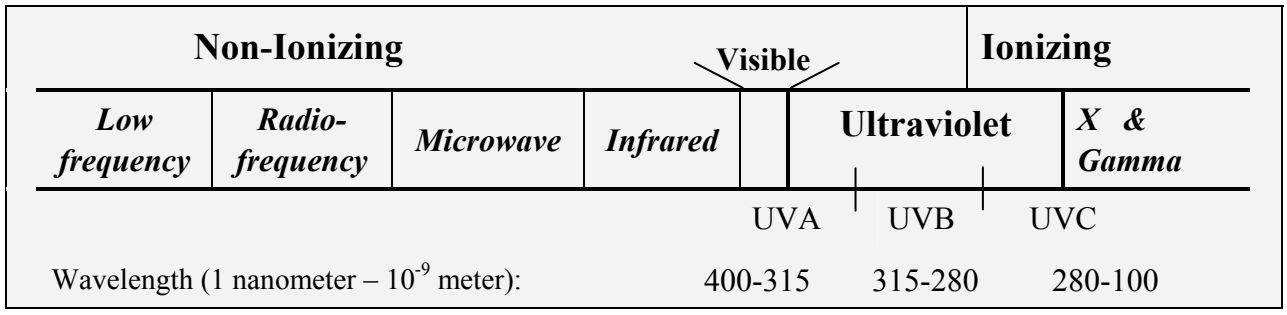

Figure 1. The Electromagnetic Spectrum

Sources of UV radiation in the workplace include various kinds of welding arcs and UV lamps. The sun is the main source of UV radiation out of doors. Most UV radiation sources also emit visible light; this is usually brilliant white, but it sometimes has a purplish hue. UV lasers emit UV radiation without producing any visible light.

Who is exposed to ultraviolet radiation on the job?

Operations that use artificial UV sources may expose workers to excessive UV radiation. These include: welding; processes involved in printing; curing of inks, paints, etc.; non-destructive testing (NTD) and material inspection; and UV disinfection in hospitals and laboratories. Outdoor workers may easily be overexposed to UV radiation from the sun during spring and summer. They include workers in construction, open-pit mining, logging, landscaping, road building and maintenance, agriculture and other sectors.

2. HEALTH EFFECTS OF UV EXPOSURE

Although exposure to small amounts of UV radiation can have beneficial effects, such as vitamin D synthesis in the skin, overexposure can cause serious acute (short-term) and chronic (long-term) health effects.

ACUTE EFFECTS

Sunburn *(medical name: erythema)*.

This is a reddening of the skin, with blistering and peeling in severe cases. Of the three UV bands, UV-B is most effective in causing sunburn. To protect itself against UV radiation, the skin "tans": that is, the pigment that gives the skin its colour becomes darker and more of it is produced. Prolonged exposure to UV radiation causes a thickening of the skin's outer layer. Since people with lighter skin, hair and eyes have less pigment, they are more sensitive to UV exposure.

Damage to the skin accumulates over the day, and the injury does not become obvious until a few hours later. Given time, sunburned skin repairs itself.

Welders' flash, also known as **arc-eye** and **snow-blindness**
(medical name: photokeratoconjunctivitis).

This is a painful irritation of the cornea and the conjunctiva (the membrane connecting the eyeball with the inner eyelid). There is a feeling of "sand in the eye" and sensitivity to light. UV-B is most effective in causing this "sunburn of the eye". The eye is more sensitive than the skin to UV radiation because it lacks the skin's horny outer layer and protective pigment.

Symptoms appear from six to 24 hours after exposure and usually disappear within the following 48 hours. No permanent damage to the eye results unless a severe exposure has occurred.

Retinal injury, possibly resulting in loss of sight, may be caused by UV radiation in people who have had the lens of an eye (the crystalline) removed, for example due to cataracts. This can be prevented with UV-absorbing lens implants or eyeglasses. In the normal eye, the retina is protected from UV injury because the crystalline filters out UV.

Recent research indicates that exposure to UV radiation can adversely affect the **immune system**.

Note: Hypersensitivity to UV radiation may result from the use of certain prescription drugs, such as tetracycline (a common antibiotic), or from exposure to some industrial chemicals, such as coal-tar distillates. Workers who may be exposed to UV radiation should ask their physicians about the possibility of sensitization when given any new prescriptions.

CHRONIC EFFECTS

Skin Cancer

Excessive exposure to UV radiation over many years has been shown to increase a person's risk of developing skin cancer. The most common types of skin cancer, **basal cell carcinoma** and **squamous cell carcinoma**, are not usually life-threatening if treated early. **Malignant melanoma** is a rarer but much more dangerous form of skin cancer.

A person's chance of getting skin cancer increases with the lifetime UV dose, that is, the total UV radiation he or she has received. The risk of getting malignant melanoma also increases with the number of blistering sunburns experienced during childhood. An alarming increase in skin cancer rates in Canada over the last few years has been attributed to the excessive sun-tanning habits that became popular in the 1950s.

Lighter-complexioned people are more likely to develop UV-related skin cancers than darker-complexioned people, so they should be particularly careful to minimize their UV exposure.

Photoaging

This is the premature aging of the skin caused by chronic exposure to UV radiation. The resulting changes in the skin include excessive wrinkling, dark spots, loss of elasticity and a leathery appearance.

Senile Cataracts

A senile cataract is a clouding of the lens of the eye in older people, often impairing vision and eventually requiring surgery. Long-term UV exposure has been shown to be an important factor in the development of this disease.

3. EXPOSURE GUIDELINES

The Ministry of Labour's Radiation Protection Service applies the threshold limit values (TLVs) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for occupational exposure to UV radiation. These limits are enforced in Ontario workplaces by the ministry under section 25(2)(h) of the Occupational Health and Safety Act.

These limits are based on UV doses that normally do not produce sunburn or eye irritation (welder's flash). They take into account the varying biological effects of different wavelengths of UV radiation. The guidelines limit the "effective Actinic UV irradiance" to three millijoules per square centimetre, accumulated over an eight-hour period.

Additionally, the total irradiance of "UV-A Spectral Region (315 to 400 nm)" on the unprotected eye is limited to 1.0 milliwatt per square centimetre for periods greater than 16.7 minutes and to 1.0 joule per square centimetre for shorter periods. (See "Ultraviolet Radiation" in the ACGIH's *Threshold Limit Values*.)

These guidelines do not apply to UV lasers or to workers exposed to hypersensitizing substances.

Measurements of UV radiation, as well as the determinations of exposure levels, allowable exposure times and compliance with the guidelines, must be carried out by a qualified person with appropriate equipment.

4. CONTROL MEASURES

The following control measures can help to prevent the overexposure of workers to UV radiation. The measures used will depend on each situation.

ENGINEERING CONTROLS

- UV radiation should be contained or confined to a restricted area when practicable.

  UV radiation can be easily contained with opaque materials, such as cardboard or wood. Transparent materials, such as glass, PVC (polyvinylchloride), plexiglass and perspex, block UV radiation in varying degrees. Generally, carbonated plastics provide adequate UV protection. Some kinds of clear glass (including some kinds of window glass and optical glass) transmit significant amounts of UV-A radiation.

- A high-power UV source should have interlocked access, so that it is shut off when the protective enclosure is open.

ADMINISTRATIVE CONTROLS

- Whenever UV radiation cannot be contained or confined, worker exposure should be minimized by limiting exposure times and increasing the distance between workers and the sources. Measurements are required to determine safe working distances and exposure times.
- Areas where exposure to UV radiation is possible should have appropriate warning signs.

PERSONAL PROTECTION

Workers exposed to UV radiation in excess of the above guidelines should use the following personal protective equipment:

- UV-blocking safety eyewear (goggles, spectacles, face shields, welding shields, etc.) with side-shields where applicable,
- long-sleeved, closely-woven clothing that covers as much of the body as practicable, and
- sun-screen with a sun-protection factor (SPF) of 30 or higher and effective against UV-A and UV-B on all exposed skin.

PREVENTING OVEREXPOSURE TO UV RADIATION FROM THE SUN

In Ontario, during the midday hours on clear summer days, UV radiation from the sun can easily exceed the exposure limits quoted above. When practicable, the exposure of outdoor workers to solar UV radiation should be minimized by:

- making use of natural or artificial shade, or
- scheduling alternative tasks when the sun is most intense.

While working in direct sunlight when UV levels are high, outdoor workers should:

- limit the amount of time you work outdoors in the sun from 11 a.m. to 4 p.m.
- seek shade as much as possible, especially during breaks
- wear a wide brim hat (8 cm or more); attach a back and side flap and visor to a construction helmet
- wear tightly woven clothing covering as much of the body as is practicable
- apply broad spectrum sunscreen with a Sun Protection Factor (SPF) of 30 or higher on exposed skin. Reapply at noon and often if perspiring heavily
- apply a broad spectrum lip balm with a SPF of 30 or higher
- wear eyeglasses that effectively filter ultraviolet rays. The ANSI Z80.3-2001 standard for non-prescription sunglasses should be followed as applicable.

Note: The use of UV-safety measures should not lead to other safety risks – the risk of head injuries from using hats with inadequate impact protection, for example, or the risk of heat stress from wearing heavy clothing in hot environments.

WHAT IS TO BE DONE WHEN WORKERS HAVE BEEN OVEREXPOSED?

Provide First Aid:

- For UV overexposure of the eye, place a sterile dressing over the eye and get medical attention.
- For UV overexposure of the skin, apply cold water or ice to the skin burns and get medical attention.

Carry Out a UV Safety Audit:

- Identify the sources and circumstances that produced the overexposure.
- Discontinue their use to prevent other incidents.
- Determine UV exposure levels and make sure that adequate controls are put in place.

HOW SHOULD A PROGRAM TO PREVENT OVEREXPOSURE OF WORKERS BE ORGANIZED?

- Prepare a list of UV sources in the workplace. Note their wavelength range and output power (if applicable) and determine their hazard potential (see Table 1).
- Review work processes and identify those that may cause UV exposure.
- Have a UV radiation survey carried out by a qualified person. Determine exposure levels, allowable exposure times, safe viewing distances and the need for personal protective equipment.
- Put in place adequate UV control measures (see Table 1).
- Update your workplace UV-safety program as new sources are introduced.

References:

2008 *Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs).* American Conference of Governmental Industrial Hygienists (ACGIH). 1330 Kemper Meadow Dr., Cincinnati OH 45240.

American National Standards Institute Z80.3-2001 "Nonprescription Sunglasses and Fashion Eyewear – Requirements" 1819 L Street, NW, 6th Floor Washington, DC, 20036.

American National Standard Z136.1-2007 for Safe Use of Lasers. American National Standards Institute (ANSI). 11 West 42nd St., New York NY 10036.

For More Information

For more information about UV radiation and radiation protection in the workplace, please call the **Radiation Protection Service** at **(416) 235-5922**.

Permission is granted to photocopy Ministry of Labour Guidelines. Please distribute them widely and post them where people will see them.

Cette publication est aussi disponible en français sous le titre « Rayonnement ultraviolet dans le lieu de travail ».

Note:
This guideline gives advice on the prevention of overexposure to UV radiation in the workplace and sets out the occupational exposure limits that are enforced in Ontario workplaces by the Ministry of Labour. It cannot cover all possible situations. The requirements set out in the Occupational Health and Safety Act must be complied with and they should be referred to when this guideline is used.

ISBN 978-1-4249-9713-8 (Print)
ISBN 978-1-4249-9715-2 (PDF)
ISBN 978-1-4249-9714-5 (HTML)

Table 1: COMMON UV SOURCES IN THE WORKPLACE

Source	Potential for Overexposure	Hazard Description	For Safety Advice Refer to:
The Sun	Very high	UV from the sun is highest in spring and summer from 11 a.m. to 4 p.m. UV guidelines can be exceeded in 15 minutes on a clear summer day. Clouds may do little to reduce UV levels.	Preventing Over-exposure to UV Radiation from the Sun
Electric Welding Arcs	Very high	Welding arcs can exceed the UV guidelines in seconds within a few meters of the arc. Besides workers, bystanders and passers-by are often overexposed to UV from the arcs.	Engineering, Administrative Controls, and Personal Protection
UV Curing Lamps	Medium	Lamps are usually inside cabinets, but substantial UV radiation can escape through openings.	Engineering Controls, Administrative Controls
Black Lights	Medium to Low	Low-power UV-A lamps used in non-destructive testing (NDT), insect control, and entertainment.	Engineering Controls, Personal Protection
Germicidal Lamps	High	UV-B- and UV-C-emitting lamps used to sterilize work areas in hospitals and laboratories.	Engineering Controls, Personal Protection
UV Lasers	High	Source of intense UV radiation at a single wavelength, with no visible light.	Laser Safety Standards (e.g. ANSI Z-136.1)
Lighting	Low	Most lamps used for lighting are made to emit little or no UV radiation.	No precautions needed under normal conditions
Tanning Lamps	High	These emit mostly UV-A radiation. They must exceed guidelines in order to cause tanning.	Not applicable to workers. Use should be discouraged

Please note that this table is intended as guidance only and is not comprehensive. The actual UV exposure levels in a workplace depend on conditions there. A UV radiation survey is required to determine the actual exposure levels at a particular workplace.