Australian Government

Australian Radiation Protection and Nuclear Safety Agency

Management Plan for Artificial Sources

Supplementary Information

April 2010

Contents

Background

ARPANSA and RPS-12

What are they?

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is a federal government agency protecting people and the environment from radiation. One of the ways ARPANSA fulfils this role is by publishing the Radiation Protection Series—a series of codes and standards explaining how to use radiation safely.

RPS 12—*The Radiation Protection Standard for Occupational Exposure to Ultraviolet Radiation*—is the 12th publication of the Radiation Protection Series (i.e. why it's called RPS. 12). It explains how to protect workers from Ultraviolet Radiation (UV) such as:

- what must be done to protect workers;
- who is responsible for protecting workers; and
- the Exposure Limits(pp.10-12).

Why has this Supplement and a Sample Management Plan been prepared?

The Management Plan for exposure to UV fulfils a requirement of RPS.12 (quoted on page 4):

"examples of a [plan for control of exposure to ultraviolet radiation] and the minimum elements required to be in the plan are given on the ARPANSA website."

This supplement supports the plan by providing extra information such as the:

- types of reflective surfaces and how much they reflect;
- causes of skin cancer and eye damage;
- things you can do in the workplace to protect workers from UV.

Where can I find more information?

Table 1. Websites You Can Visit For More Information

WEBSITE	WHAT IT SHOWS
www.arpansa.gov.au	ARPANSA website homepage
www.arpansa.gov.au/AboutUs/index.cfm	what ARPANSA is and does
www.arpansa.gov.au/Publications/codes/rps.cfm	Radiation Protection Series homepage
www.arpansa.gov.au/Publications/codes/rps12.cfm	where and how to download the Standard for Occupational Exposure to UV

Ultraviolet Radiation/UV/UVR

What is it?

Put simply, UV is invisible rays or energy (known scientifically as radiation) that mainly come from the sun. Other types of radiation the sun emits include:

- light (visible radiation)—the colour we can see; and
- heat (infrared radiation)—the heat we can feel from a car, a heater or the sun.

We can see light and feel heat but none of our senses can detect UV. That's why you get sunburnt at the snow yet it's freezing cold. Therefore, the presence of heat does not indicate the presence of UV meaning you can receive high UV exposure without even noticing e.g. a germicidal UVC lamp produces very high UV but not much heat (infrared radiation).

Where does it come from?

Although almost all UV we encounter comes from the sun, some UV also comes from Artificial Sources (see *What is an Artificial Source?* below) such as:

- mercury lamps;
- arc welders;
- fluorescent lamps;
- germicidal lamps;
- metal halide lamps;
- fluorescent sunlamps;
- fluorescent tubes;
- hydrogen lamps;
- deuterium lamps; and
- flash tubes.

Why is it dangerous?

UV from the sun causes almost all UV-related diseases and injuries e.g. skin cancers, skin burns and eye damage. However, Artificial Sources (welding equipment, solaria, etc) used incorrectly can also cause these same health effects. It is therefore essential that a plan is created, followed and maintained for Artificial Sources so that employees are kept safe.

Where can I find more information?

See the following websites:

- www.sunsmart.com.au/ultraviolet_radiation/understanding_uv
- www.arpansa.gov.au/RadiationProtection/FactSheets/is_UVIndex.cfm

What is an Artificial Source?

Artificial Sources are man-made objects or items that produce UV. Some Artificial Sources are specifically designed to produce UV—UVC lamps used for sterilisation—while others produce UV indirectly—welding equipment. The following 7 categories classify the different types of Artificial Sources:

1) Incandescent Sources
    a) tungsten lamps
    b) quartz-halogen lamps
2) Gas Discharge Lamps
    a) germicidal lamps
    b) mercury lamps
    c) mercury lamps with metal halides
    d) xenon lamps
    e) hydrogen and deuterium lamps
    f) flash tubes
3) Fluorescent lamps
    a) general lighting fluorescent lamps
    b) fluorescent lighting tubes
    c) fluorescent sunlamps
    d) fluorescent UVA tubes
    e) electric discharges
4) Welding/Cutting Arcs
    a) portable oxy-fuel gas equipment; or
    b) plasma arcs
    c) carbon arcs
5) UVR-emitting LED's
6) Optical components and filtering
7) Equipment/machinery or objects that contain the aforementioned UVR sources

Only sources producing enough UV to *exceed* Exposure Limits (pp.10-12 of RPS 12) within an 8 hour period are considered Artificial Sources. Other items (such as computer screens or normal light globes) produce small amounts of UV but not enough to exceed Exposure Limits; this means they are not considered Artificial Sources.

1. Purpose and Objective

This section gives information on the risks this plan is intended to provide protection against.

Skin Cancer

What is skin cancer?

Put simply, skin cancer is an abnormal growth (known medically as a tumour) of skin cells.

What causes skin cancer?

UV from the sun is the main cause of skin cancer. Normally, old damaged skin cells die and new ones take their place. This occurs in a very orderly, controlled process. However, when skin is exposed to high levels of UV, skin cells can become severely damaged causing them to not work properly. Skin cells that don't work properly can either grow abnormally or don't die as they're supposed to. These abnormal cells can then increase in number which is then seen as a small growth called a cancer, tumour or more commonly a carcinoma. The type of cancer that forms depends on the skin cell. For example, squamous cell carcinoma is a cancer of squamous cells, basal cell carcinoma is a cancer of basal cells and melanoma is a cancer of melanocyte cells.

What types of skin cancer are there?

There are three main types of cancer:

- squamous cell carcinoma;
- basal cell carcinoma; and
- melanoma.

SQUAMOUS CELL CARCINOMA

Squamous cell carcinoma affect squamous cells which lie in the top-most layers of skin. These cells are important because they produce keratin—a tough fibrous protein that keeps skin moist yet tough. This cancer can spread to organs of the body and lymph nodes (parts of the body where immune cells grow). Squamous cell carcinoma is less common than basal cell carcinoma (see below) but more aggressive—once it spreads to the body, it becomes very difficult to control. For more information, see:

www.cancervic.org.au/about-cancer/cancer_types/skin_cancers_non_melanoma/#squamous_cell_carcinoma

BASAL CELL CARCINOMA

Basal cell carcinoma affects basal cells—small, round cells that lie below squamous cells. Basal cells are important because they replace squamous cells which die every 30 days or so. Although basal cell carcinoma is the most common skin cancer, it is slow growing and doesn't usually spread making it easier to treat. For more information, see:

www.cancervic.org.au/about-cancer/cancer_types/skin_cancers_non_melanoma/#basal_cell_carcinoma

MELANOMA

Melanoma is a cancer of skin cells called melanocytes—skin cells that lie in the bottom layers of skin. Melanocytes produce melanin—the pigment that gives skin its tanned colour—which is why they are commonly known as pigment cells. When skin is exposed to the sun, melanocytes respond by producing melanin which offer very small levels of UV protection. However, when melanocytes are exposed to too much UV from sunlight, they can become damaged and begin functioning abnormally i.e. they begin growing very rapidly or don't die when they're supposed to. Melanoma is the rarest form of skin cancer but also the most aggressive and dangerous—1200 Australians die from melanoma each year. For more information, see:

www.cancervic.org.au/about-cancer/cancer_types/melanoma/

Who gets skin cancer; what burden does it have on tax payers?

Skin Cancer kills over 1700 Australians each year. Deaths from skin cancer exceed the number of road toll deaths. Australia has the highest rate of skin cancer in the world—four times the rate of Canada, USA and UK. Each year 434,000 people are diagnosed with skin cancer despite it being almost entirely preventable. Excessive exposure to the Sun causes almost all skin cancers.

Skin Cancer costs Australian taxpayers over $300 million per year. Related absenteeism costs are in excess of $50million per year with unknown costs to victims' families and friends. Insurance premiums continue to soar as more cases go to court.

More information can be found at**:**

- www.sunsmart.com.au/about_us/our_research/facts_and_stats_at_a_glance
- www.workcover.nsw.gov.au/formspublications/publications/Documents/skin_cancer_and_outdoor_workers_employers_0116.pdf

Erythema

What is it?

Erythema (also known as skin burn or sun burn) is a reddening of skin and can often result in skin peeling or blisters.

What causes sunburn?

Erythema occurs because skin cells have been overexposed to UV. Overexposed skin cells trigger an immune response causing an increased blood supply to the skin surface. The extra blood is seen as erythema or reddening of the skin. First signs of erythema are observed 3-5 hours after exposure and reaches maximum after 8-12 hours. Unlike other hazards to the skin, overexposure to UV is not noticed immediately i.e. you only notice after you've already been burnt. Mild erythema from small overexposures disappears within a few days. Higher overexposure results in:

- pain;
- skin swelling (oedema);
- blistering; and
- peeling.

How badly you burn depends on:

- the intensity of the UV rays you've been exposed to;
- how long you've been exposed; and
- how well protected you are while being exposed.

How can you tell whether you have skin cancer?

Skin spots that have changed colour, size or shape are an indication of skin cancer. You should seek medical advice as soon as this occurs since early detection leads to more successful treatment. Although many cancers can be treated, protection and prevention from UV should always come first. For more information, visit the website below:

- www.sunsmart.com.au/download.asp?RelatedLinkID=273
- www.sunsmart.com.au/download.asp?RelatedLinkID=272

Eye Damage

UV can damage the eyes as well as the skin. Damage to the eyes is either:

- Immediate i.e. happens within about 48 hours
- Long term i.e. happens years later due to earlier over-exposures

Immediate Effects

The following 2 things happen within about 48 hours after being overexposed to UV:

- Photokeratoconjunctivitis; and
- Acute Cataract Formation.

PHOTOKERATOCONJUNCTIVITIS

This eye disorder is commonly known as welder's flash or snowblindness. Two problems occur with this kind of eye damage (hence the name Photokeratoconjunctivitis):

- Keratitis—the clear front window at the front of the eye (the cornea) becomes inflamed; and
- Conjunctivitis—the clear window or membrane covering the 'white parts' of the eye (the conjunctiva) becomes inflamed.

Symptoms occur within a few hours and include the following:

- feeling of itchiness (as if sand is in the eye);
- swelling;
- loss of the superficial cells in the cornea;
- increased tearing; and
- severe pain due to photophobia (being sensitive to bright light).

ACUTE CATARACT FORMATION

Artificial Sources can cause cataracts (cloudiness of the eye lens that disturbs vision).

Long-Term Effects

The following 4 disorders can occur many years after the eyes have been over-exposed to UV.

- Pterygium;
- Pingueculum;
- Droplet Keratitis; and
- Cataracts.

PTERYGIUM

Pterygium is a fibrous or wing-like growth on the cornea (from the Greek *pteryg* meaning *wing* or *fin*). Symptoms include the cornea becoming opaque making vision difficult.

PINGUECULUM

Pingueculum is deposit of protein and fat on the conjunctiva—the clear window or membrane covering the 'white parts' of the eye. This often grows across into the cornea becoming pterygium and affecting vision.

DROPLET KERATITIS

Droplet Keratitis is inflammation of the cornea that affects transparency (i.e. how much light enters the eye). This results in objects appearing hazy and vision being blurred.

CATARACTS

Results in a clouding of the lens that disturbs vision. In most cases it can be removed surgically.

2. Duties and Responsibilities

This section explains some of the safety aspects employers and employees are responsible for.

Maintaining a Plan—what should be considered.

Employers are responsible for maintaining a Management Plan for Artificial Sources. Proper maintenance means employers should do the following:

- revise the plan at least every 2 years;
- consult with employees when writing or revising the plan;
- ensure employees know how to follow the plan; and
- ensure employees follow the plan.

Occupational Health and Safety Acts

What are they?

The Occupational/Workplace Safety Act of each jurisdiction[1] ensures the safety of employees at work. Each jurisdiction has its own Occupational/Workplace Safety Act (see Table 2 below) meaning OH&S acts differ only slightly between one another such as the:

- name of the act: some jurisdictions call them Occupational Health and Safety Acts while others call them Workplace Health and Safety or even Workplace Health, Safety and Welfare; and
- penalties: how high penalties are for certain elements/parts.

No matter the jurisdiction, *all* OH&S acts have the same:

- purpose—to keep employees safe at work;
- employer and employee duties and responsibilities (albeit in slightly different words).

In addition, Commonwealth, state and territory governments signed an intergovernmental agreement in July 2008 saying they will, "harmonise OHS legislation by 2011 or earlier". This means the few elements that are different will be changed to be more uniform. See the Intergovernmental Agreement for Regulatory and Operational Reform in Occupational Health and Safety:

www.coag.gov.au/coag_meeting_outcomes/2008-07-03/docs/OHS_IGA.rtf

Table 2. Where to Find Copies of OH&S Acts of Each Jurisdiction

Government	Website
Federal	www.austlii.edu.au/au/legis/cth/consol_act/ohasa1991273/
NSW	www.austlii.edu.au/au/legis/nsw/consol_act/ohasa2000273/
VIC	www.austlii.edu.au/au/legis/vic/consol_act/ohasa2004273/
SA	www.austlii.edu.au/au/legis/sa/consol_act/ohsawa1986336/
WA	www.austlii.edu.au/au/legis/wa/consol_act/osaha1984273/
TAS	www.austlii.edu.au/au/legis/tas/consol_act/whasa1995250/
QLD	www.austlii.edu.au/au/legis/qld/consol_act/whasa1995250/
ACT	www.austlii.edu.au/au/legis/act/consol_act/rpa2006228/
NT	www.austlii.edu.au/au/legis/nt/consol_act/rca263/

[1] Jurisdiction is the area in which a law (i.e. the Occupational or Workplace Health and Safety Act) or administrative power (i.e. Workcover) has authority. For example, Workcover NSW can only enforce the NSW Occupational Health and Safety Act in NSW, not in Victoria.

Why are they important?

The OH&S acts are important for employers (to protect their workers) and employees (to ensure they follow safety procedures to protect themselves).

What employers are required to do under the Act?

The following, quoted directly from the Federal Occupational Health and Safety Act (1991), outlines what employers must do.

Employers must:

1. *take all reasonably practicable steps to protect the health and safety at work of their employees;*
2. *provide and maintain a working environment that:*
   - *is safe for the employer's employees and without risk to their health; and*
   - *provides adequate facilities for their welfare at work;*
3. *provide to the employees, in appropriate languages, the information, instruction, training and supervision necessary to enable them to perform their work in a manner that is safe and without risk to their health.*

Penalties for employers not complying with points 1, 2 and 3 are 3500 penalty units ($386,000 as of 2009).

What employees are required to do under the Act?

The following, quoted directly from the Victorian OH&S Act (2004), outlines what employees must do.

Employees must:

1. *take reasonable steps to ensure his or her own health and safety whilst at work;*
2. *cooperate with his/her employer —with respect to actions taken by the employer to comply with the Act;*
3. *not intentionally or recklessly interfere with or misuse anything provided at the workplace that is used for Occupational Health and Safety.*

Penalties for Employees not complying with points 1, 2 and 3 are 1800 penalty units ($210,276 as of 2009).

Has anyone been sued for not adequately protecting their employees?

A number of cases have occurred where the employer has been sued for negligence for not adequately protecting their workers. Insurance premiums will soar as more cases go to court. Web-links (below) give examples:

- www.wcc.nsw.gov.au/NR/rdonlyres/25524629-03D7-46F4-82BA-C8DD5A3EB7E9/0/WCC643404.pdf
- www.countycourt.vic.gov.au/CA256D90000479B3/Lookup/Judgments_R/$file/reeder_boral.pdf
- www.wcc.nsw.gov.au/wcc/ccr/12026-97.pdf

3. Assess the Risks

This section tells you what things to consider when assessing the exposure to the UV.

What is a risk assessment?

We encounter many risks in life—driving a car, crossing the street, riding a bike. We also encounter many risks whilst at work. A risk assessment aims to find these potential risks or hazards, prioritising them in order of how dangerous they are, or how likely they are to occur. You should include UV exposure from Artificial Sources in your risk assessment.

How do you perform a risk assessment?

To perform a risk assessment, you should do the following:

1) locate and identify Artificial Sources;
2) collect and read available data/documentation;
3) conduct a work task analysis;
4) perform measurements if necessary.

Locate and identify the Artificial Sources

This is fairly obvious—work out whether you have any Artificial Sources (see pp.2) and find out where they are located. This will be important for the following steps.

Collect and read available data/documentation

Some Artificial Sources will have accompanying documentation related to repairs, calibration, maintenance, purchase, operating instructions, safety precautions, etc. The type of information that is useful for estimating exposure includes:

- the material the lamp is enclosed in;
- the size or shape of the source;
- whether other wavelengths (in smaller quantities) are also produced; or
- how much UV is actually produced.
- wattage;
- primary emitted wavelengths;
- power; or
- amps/voltage
- safe work distances;
- safety precautions/procedures i.e.
    - what clothing to wear;
    - how to handle e.g. use in a fume cupboard or surround with polycarbonate shielding;
    - what is a safe working distance; and
    - how operators should be trained.

The International Commission on Illumination (CIE)—the international peak body for protection against UV—has created a Standard[2] to categorise lamps and lamps systems. Lamps or lamp systems that comply with the Standard and are exempt or fall into Risk Group 1 may not require further measurements since the UV they emit does not pose a health risk.

Your regulatory authorities may also have requirements for certain types of Artificial Sources e.g.

- operators must have certain qualifications i.e. degrees, certificates, competencies etc;
- users must obtain certain licences or permits; or
- employers must implement safety measures/precautions.

If these are given they must be followed.

Conduct a work task analysis

WHAT IS A WORK TASK ANALYSIS?

A work task analysis helps estimate or calculate an employee's exposure. To do this, examine all working steps of employees who work with (or near) Artificial Sources.

WHO SHOULD CONDUCT A WORK TASK ANALYSIS; WHAT THEY SHOULD KNOW?

Individuals conducting a work task analysis should know some or all of the following:

- how to calculate UV exposure;
- how to implement UV Control Measures (see Control Measures pp.13);
- the work environment, conditions or hazards present at the workplace/worksite such as:
    - dust;
    - close to public access;
    - enclosed space;
    - unventilated;
    - workers nearby; and
    - walk-through traffic etc.; and
- the work processes inside out e.g.
    - which jobs are done;
    - where they are done;
    - what processes/steps they involve;
    - how they are performed; and
    - who (which employees) performs them.

Anyone knowing the above could conduct a work task analysis e.g:

- Employees;
- Health and Safety Officers; or
- Health and Safety Committees etc.

[2] CIE/IEC 62471:2006-Photobiological Safety of Lamps and Lamp Systems

HOW IS A WORK TASK ANALYSIS CONDUCTED

A work task analysis should be conducted according to steps 1-8 below:

1) Locate and identify employee(s) who may be exposed

Which employees are exposed to UV from an Artificial Source? There are many employees who could be exposed; the following are examples:

- employees who use, maintain, repair or operate Artificial Sources;
- employees who perform other tasks or jobs near Artificial Sources; or
- employees who will be near Artificial Sources and could exceed therefore Exposure Limits.

2) Ask employees whether they have ever been overexposed

Have employees suffered from an over-exposure? Knowing whether employees were overexposed is important to find out where to focus a work task analysis. Employees who suffered effects of overexposure (e.g. mild erythema, photokeratoconjunctivitis etc) and the jobs or tasks they were doing should be examined first.

3) Identify point(s) where employees are located

Where do employees spend time during the course of their work? This step finds all points or areas where an employee could receive a UV exposure to determine:

- how far they are from the Artificial Source(s) when using or in close-proximity to it; and
- what parts of their body are exposed.

Table 3 (below) shows safe working distances for common Artificial Sources. You may not need to identify points or areas where employees work if they are outside the safe working distances shown below.

Table 3. Approximate Safe Working Distances for Artificial Source(s)

Artificial Source	Approximate Safe Distances (metres) Over an 8 Hour Period
Germicidal Lamp	12
Arc or Welding Cutting Arcs	10
1000WFEL Calibration Lamp	1.8
100W UVB Tube	0.2 (20cm)
100W UVA Tube	0.02 (2cm)
Solarium 100W	0.03 (3cm)
300W Xenon Solar Simulator	0.16 (16cm)
Mercury Pencil Lamp	1
Deuterium Lamp	0.25 (25cm)

Notes: These are approximate values only. They apply to only 1 source i.e. 1 deuterium lamp or 1 germicidal lamp. It assumes the source is not in the source housing and irradiance it unobstructed i.e. assumes a germicidal lamp is not in the source housing and is directly irradiating you.

4) Calculate how long employees are located at each point

How long do employees spend at points identified in Step 3? As an example, employees may spend 5 minutes at point 1—which is 5 metres away from the source—or 1 minute at point 2—30cm away from the source. It is usually too difficult to assess the time spent at all points identified in Step 3. Instead, focus on points where exposure will be highest calculating time spent using a stopwatch or asking employees directly.

5) Examine what control measures are used

What control measures are being implementing? For example, employees may be:

- doing nothing;
- using certain protective measure at certain locations/times or during certain procedures e.g. wearing protective eyewear and clothing when using the Artificial Source but not wearing any PPE (see page 27) when in close-proximity to it; or
- implementing protective measures at all times.

Taking note of what control measures are being implemented is important to assess employee exposure.

6) Examine the surrounding environment

What environment surrounds the Artificial Source? The Artificial Source may be surrounded by shielding (decreasing exposure to employees) or reflective surfaces (increasing exposure). Therefore you should determine whether there is:

- shielding e.g. made of steel, wood; or plastic; or
- enclosures e.g.
  - Walls;
  - Doors;
  - Screens;
  - Safety-Interlocks; or
  - Cabinets.
- ozone (see page 12);
- reflective surfaces (see page 12); or
- secondary hazards (see page 27).

7) Determine 'worst-case' scenario to calculate exposure

Use information from previous steps to roughly calculate employees' exposure for a 'worst-case scenario'. You could use the following parameters to do this:

- distances to the Artificial Source(s);
- exposure times;

- absence of protective measures; and
- presence of hazardous material.

As an example, in a 'worst-case scenario', an employee could be 20cm next to the source for 4 hours, use no protective measures and there could be reflective material present. You can calculate exposure over any length of time but 8 hours is best—it allows easy comparison to Exposure Limits (see Step 8 below). Ensure you use all information collected including the first two steps of *How to perform a risk assessment?* Together, this should be enough information to calculate exposure.

8) Compare the worst-case scenario to the exposure limits (pp.10-12 of RPS 12).

How do 'worst-case scenario' exposures compare with exposure limits? The result you get will be one of following:

- Result 1: *exposures for the worst case scenario are well below Exposure Limits;*
- Result 2: *exposures for the worst case scenario are well above Exposure Limits; and*
- Result 3: *exposures for the worst case scenario are just below or just above Exposure Limits.*

Result 1 is simple: for employees not receiving exposures anywhere near exposure limits, no further action is required.

Result 2 means further assessment is unnecessary but Control Measures (see pp.14) must be implemented immediately.

Result 3 gives you the following two options:

- implement control measures to keep exposures well below Exposure Limits; or
- perform further measurements with detection equipment.

In many situations, implementing appropriate control measures is easy, cheap and effective. Many control measures are available that would suit your work situation (see pp.14 for more info). To know how to perform measurements, see below.

Perform measurements if necessary

As shown from Part 8 of the work task analysis, you may with to perform measurements if worst-case scenario results are close to Exposure Limits. The problem is performing measurements with equipment can be difficult and expensive. UV-detection equipment can be thousands of dollars and measurements have a high degree of error (about 10-30%). It is often best to avoid measurements and simply implement appropriate control measures.

Reflective Surfaces

What are Reflective Surfaces; why are they important?

Reflective surfaces reflect UV. The rule-of-thumb is if natural light can reflect off something, so can UV. Some material reflects a lot (e.g. snow) while others do not reflect much (e.g. grass). The more reflective these surfaces are, the more dangerous they are.

What are the types of reflective surfaces?

Examples of reflective surfaces include:

- water;
- reflective building glass;
- sand;
- rock;
- cement;
- snow;
- white/light-coloured/reflective paint;
- light coloured concrete; and
- unpainted, metallic surfaces i.e. corrugated steel or aluminium roofing.

How much UV do different types of material reflect?

Table 4. Percentage of UV Reflected by Different Material

MATERIAL	PERCENTAGE REFLECTED
Lawn grass, summer/winter	2.0 – 5.0
Grasslands	0.8 – 1.6
Soil, clay/humus	4.0 – 6.0
Asphalt roadway, new (black), old (grey)	4.1 – 8.9
House paint, white	22.0
Boat deck, wood/fibreglass	6.6% – 9.1
Open water	3.3
Open ocean	8.0
Sea surf, white foam	25.0 – 30.0
Beach sand, wet	7.1
Beach sand, dry, light	15.0 – 18.0
Snow, old/new	50.0 – 88.0
Concrete footpath	8.2 – 12.0

Source: Sliney DH. Physical factors in cataractogenesis: Ambient ultraviolet Radiation

4. Control Measures

This section describes the different types of controls measures and control priorities.

What are Control Measures?

Control measures are things you do to reduce UV exposure. You have many options such as: installing shielding, wearing protective eye wear, installing barriers, etc. To list every control measure would be tedious: there are hundreds of them and what works in one situation won't work in another. Instead, RPS 12 groups control measures into control priorities shown below:

a) Elimination

b) Substitution

c) Engineering Controls

d) Administrative Controls

e) Personal Protective Equipment

The 5 control priorities are ranked in order of their effectiveness (e.g. engineering controls are more effective than administrative controls) and how they should be implemented (e.g. use elimination before substitution). These control priorities must be implemented if an employee's exposure will exceed Exposure Limits.

What is Elimination?

According to the Standard, Elimination means eliminate the hazard i.e. the Artificial Source. Rarely can you implement this control measure since most Artificial Sources have a specific purpose. In some cases, Artificial Sources generate UV but serve no purpose or have been superseded; these should be eliminated or removed.

What is Substitution?

Substitution means replacing a hazardous Artificial Source with one that is less hazardous. For example, a UVC lamp or germicidal lamp with a lower irradiance may be just as effective as one with a higher irradiance. In substitution, the Artificial Source replacing the original should be less hazardous but should still do the same job.

What are Engineering Controls?

Engineering Controls are physical changes to the workplace e.g. erecting barriers, installing alarms, putting the source in a secure room or container. The following 6 categories of engineering controls classify the type of changes you can make:

- install shielding.
- enclose the source.
- install fail-safe interlocks.
- install detectors or alarms.

- eliminate reflected UVR.
- remove ozone.

Install Shielding

Installing shielding is one of the most effective Engineering Controls. It prevents UV reaching employees or restricts employees gaining access to Artificial Sources in-operation. Example are shown below:

- light-tight cabinets;
- lights-tight enclosures;
- UVR-absorbing glass;
- baffles;
- shields (made from plastic, polycarbonate, wood steal etc); and
- curtains.

Ensure any material used to block UV does not (or will not) create a Secondary Hazard (see pp.25). The following materials are listed in order of their UV protection:

- tiles or ceramic;
- aluminium, tin, timber;
- polycarbonate, fibreglass, clear or tinted plastic;
- heavy textiles such as canvas, thick umbrella fabric; or
- shade-cloth or sail-cloth.

These shields are only required when Artificial Sources emit UV. In most cases, shields can be removed if the source is switched off i.e. there is no need for shielding if the source is off and does not emit UV.

Enclose the Source

Enclosing the Source is a very effective engineering control. Examples include the following:

- placing the source in a lockable room; or
- placing fencing around the Artificial Source(s).

Install Fail-Safe Interlocks

When direct access to Artificial Sources is required (e.g. for maintenance, service and repairs), fail-safe interlocks prevent accidental exposures. As an example, safety interlocks on germicidal irradiation systems cut power to the UV lamp when the door is open. Some Artificial Sources have inbuilt safety interlocks while those that don’t can have them installed.

Install UVR Detector/Alarms

Detectors or alarms notify employees when dangers are present. For example, water purifiers contain UVR Detectors which alarm when the tube is faulty or needs replacing. These can also be installed to alert employees of the dangers.

Eliminate Reflected UV

Eliminating reflected UV is important to reduce exposure (see Reflective Surfaces pp.13). In some situations, eliminating the reflective surface by removing it altogether is difficult. Instead, you should try cover the reflective surface with something that is:

- dark in colour (ideally, it should be as close to black as possible);
- does not have a shiny surface;
- is thick and dense i.e. does not have holes or spaces which allows UV through
- does not create a secondary hazard;

For example, a dark coloured material or matte-finish black paint could be used.

Remove Ozone

Ozone is created when UV reacts with oxygen. UV from the sun creates ozone in the atmosphere; UV from Artificial Sources—especially those emitting high levels of UVC such as germicidal lamps—create ozone in the workplace. If your Artificial Source produces ozone, ensure safety precautions are implemented. This will stop employees inhaling ozone which can cause the following symptoms:

- chest pain;
- coughing;
- throat irritation;
- congestion;
- worsen
- bronchitis;
- emphysema;
- asthma;
- reduce lung function/inflame the linings of the lungs; and
- permanently scar lung tissue after repeated exposure.

Some Artificial Sources may indicate ozone is produced and ventilation is required e.g. use the source in a fume cupboard. For other sources, no warning will be given so rely on your sense of smell—ozone smells like burning electrical wires or equipment. Once you can tell ozone is present, turn off the source, move away and try ventilate the area. If employees need access to an area where ozone is present then ventilation will be required.

The following document will help you assess ozone exposure is:

- *Documentation of the Threshold Limit Values and Biological Exposure Indices, 7th Ed* www.acgih.org/Store/ProductDetail.cfm?id=1873.

What are Administrative Controls

EDUCATION AND TRAINING

Educate or Train employees so they know how to protect themselves from UV. Training should be proportional to the risk e.g. it would be pointless to train an employee who spends no time near an Artificial Source. At the same time, employees using dangerous Artificial Sources should receive detailed training. Consider the following when deciding what training to provide:

1) Expertise/Awareness of Staff

Experienced workers may be aware of the risks and know how to implement safety precautions. In this case, detailed training may be unnecessary;

2) Risk Assessments;

If UVR risks are low, formal training may be unnecessary. If risks are high however, detailed safety training must be implemented.

3) Participation in Risk Assessment

Some workers are required to conduct or review risk assessments. In such cases, they may be better informed than those workers that aren't.

4) Stability of Risks

Some risks remain the same e.g. you have the same Artificial Source in the same place. In such cases, only refresher training may be required from time-to-time. If risks change significantly, then new training must be implemented e.g. if you get an arc welding apparatus after only having a germicidal lamp.

5) Availability of External Expertise

If no external expertise is available, employees may need to have a higher level of training in order to conduct their work safely.

Although the employer is primarily responsible, he/she does not necessarily have to give the training e.g. it can be given by a:

- contractor;
- other employee(s); or
- be in the form of a written or online test.

Below is some aspects that may be included in the training:

- costs to society each year from skin cancer;
- deaths each year from skin cancer;
- number of new, skin cancer cases detected each year;
- the causes of skin cancer;
- the risks and health effects of over-exposure to UV;
- how to protect oneself from UV;
- legal and monetary penalties for not protecting oneself from UV;
- how to effectively examine one's own skin for signs damage;
- how to safely use or work next to the Artificial Source(s) at the workplace;

- how to follow this plan; and
- where access is restricted forbidden and for whom (see below).

ACCESS

Restricting access means warning employees where they can and can't go. The level of restriction should be proportional to the risk. For example, if an Artificial Source is very dangerous, only certain employees should be granted access.

The type of restriction depends on the risk and the specific work situation. For example, restriction may be absolute (e.g. employees cannot access this area) or conditional (e.g. an employee can only access certain areas if they: are accompanied by someone; are appropriately trained; or wear adequate PPE—see below). Access might also be based on distance, time, or both e.g. you cannot be closer than 3 metres to the Artificial Source or cannot stay longer than 5 minutes, etc. You should also ensure employees or contractors doing maintenance or repairs are informed of where access is restricted.

The employer can inform employees of restricted access by:

- instructing employees e.g. inform employees verbally or through written instructions.
- placing signs e.g. outside a room with an artificial source or in compliance with Australian Standards (see SIGNS below).

SIGNS

Signs help remind, protect or warn employees of dangers in the workplace e.g. UV exposure from an Artificial Source. Any sign you display should comply with Australian Standards or International Standards e.g.:

- *Safety Signs Directive (92/58/EEC);*
- *AS/NZS 2243.5:2004-Safety in Laboratories Part 5: Non-ionizing radiations—Electromagnetic, Sound and Ultrasound; and*
- *AS 1319-1994-Safety Signs for the Occupational Environment.*

Compliance with these Standards will ensure signs are clear and unambiguous (see *AS 1319-1994;* pp.7). It is important to display signs when there is a real danger of over-exposure otherwise employees are likely to ignore their warnings or instructions.

Signs could contain the following information:

- to wear PPE (see below) when working with certain Artificial Sources or performing jobs or tasks in close proximity to Artificial Source;
- how to wear PPE correctly;
- the dangers of UV over-exposure;
- warn employees that it is against the law to not follow or avoid using UV protective measures;
- what employees must do when control measures are implemented;
- how to protect oneself properly against UV exposure;
- where access is restricted, limited or forbidden and to whom it applies;

- where and what UV hazards are present; and
- identifying the Artificial Source(s) present at the workplace.

Where can I find more information?

Table 5. Where to Find More Information on Engineering Controls

ARPANSA WEBSITE	WHAT IT SHOWS
www.arpansa.gov.au/uvrg/products.cfm#2	Textiles that have been UPF-tested by ARPANSA. Contact details of manufacturers who have had their textiles UPF tested.
www.arpansa.gov.au/uvrg/products.cfm#6	Contact details of manufacturers or suppliers of other products and services i.e. window tinting films.

What is Personal Protective Equipment (PPE)?

PPE is what you wear to protect yourself against UV. Of all the control measures available, this should be lowest on the priority list i.e. implement other control measures first. There are 2 main types of PPE:

- Clothing; and
- Eye Protection.

CLOTHING

Manufacturers of Artificial Sources often recommend protective clothing. Always use the recommended PPE which often protects against UV as well e.g. PPE that protects against heat or flame will usually protect against UV also. If specific clothing is not mentioned by the manufacturer, use clothes that comply with Australian or International Standards such as:

- *AS/NZS ISO 2801:2008-Clothing for protection against heat and flame—General recommendations for selection, care and use of protective clothing; and*
- *AS/NZS 4502.3:1997-Methods for evaluating clothing for protection against heat and fire—Evaluation of the behaviour of materials and material assemblies when exposed to small splashes of molten metal*
- *AS/NZS 4501.2:2006-Occupational protective clothing—General requirements*
- *AS 4502-Occupational protective clothing—Guidelines on the selection, use, care and maintenance of protective clothing*

Other protective features to look for (in addition to compliance with the standard) are clothes that cover as much unprotected skin as possible. Exposure often occurs between areas of good protection e.g. wearing a lab coat and gloves but being burnt on the wrist where the labcoat cuff is open. To avoid this:

- ensure clothing overlaps e.g. gloves with a long, wide neck which overlaps the cuff;
- tuck clothing inside one another e.g. tucking in a shirt so UV cannot penetrate from underneath the shirt; or

- ensure clothing is tight-fitting so it won't move around allowing previously covered skin to be exposed.

The standards below will help with selection and use of gloves:

- *AS/NZS 2161.1:2000 Occupational Protective Gloves -Selection, Use and Maintenance*
- *AS/NZS 2161.2:2005 Occupational Protective Gloves -General Requirements*

Thick, dark, densely woven clothing (e.g. denim, heavy-duty cotton work-wear, trades workwear) will protect very well against UV—even for strong Artificial Sources.

WHAT IS UPF?

The Ultraviolet Protection Factor (UPF) indicates the level of UV-protection a garment or hat offers. Personal apparel, clothing and textiles are given a UPF rating using the Australian/New Zealand Standard—*AS/NZS 4399:1996 Sun Protective Clothing-Evaluation and Classification*. UPF goes from 15+ (good protection) to 50+ (excellent protection). ARPANSA helped develop the standard and commercially tests garments, textiles and personal apparel. Because UV can penetrate through clothes—especially those made of thinly woven, light coloured fabric—it is important clothes meet the standard.

The following factors contribute to the UPF-rating:

- composition of the yarns (cotton, polyester, etc);
- tightness of the weave or knit (the tighter, the better);
- colour (darker colours are better);
- stretch (stretched fabrics are thinner therefore lowering its UPF);
- moisture (many fabrics have lower ratings when wet);
- condition (worn and faded garments may have reduced ratings); and
- finishing (some fabrics are treated with UV absorbing chemicals).

MORE INFORMATION?

See Table 10 (page 29).

EYE PROTECTION

SUNGLASSES

Normal everyday sunglasses will protect well against UV if they comply with the Australian New Zealand Standard—*AS/NZS 1067:2003-Sunglasses and Fashion Spectacles*. To comply, the following information must be supplied with every pair of assembled sunglasses and individual sunglass lenses:

- identification of manufacturer or supplier;
- lens category number and description (see Table 6 below); and
- for photochromic lenses, both lens categories shall be named and described.

Table 6. Requirement of Sunglasses with the AS/NZS 1067:2003 Standard

Lens category	Description	Additional markings
0	**Fashion spectacles - not sunglasses** very low sunglare reduction - some UVR protection.	NONE
1	**Fashion spectacles - not sunglasses** limited sunglare reduction - some UVR protection.	**NOT SUITABLE FOR DRIVING AT NIGHT**
2	**Sunglasses** - medium sunglare reduction and good UV protection	NONE
3	**Sunglasses** - high sunglare reduction and good UV protection	NONE
4	**Special purpose sunglasses** – very high sunglare reduction and good UV protection	**MUST NOT BE USED WHEN DRIVING**

Other protective features to look out for (in addition to compliance with the Standard) are Sunglasses that:

- are close-fitting;
- cover as much of the eyes as possible;
- have a high EPF rating of 9 or 10; and
- are tinted.

PROTECTIVE EYEWEAR

Use the following Standards to find protective eyewear:

- *AS/NZS 1336:1997-Recommended Practices For Occupational Eye Protection.*
- *AS 1338.1:1992-Filters for eye protectors Part 1: Filters for protection against radiation generated in welding and allied operations*
- *AS 1338.2:1992-Filters for eye protectors Part 2: Filters for protection against ultraviolet radiation*
- *AS/NZS 1337-Eye Protectors for Industrial Applications.*

<u>AS/NZS 1336:1997</u>

This Standard explains how to select the appropriate eye protector when working with:

- molten metals;
- harmful gases;
- vapours and aerosols; and
- high intensity radiation generated during welding operations and furnace work.

According to *AS/NZS 1336:1997,* consider the following when selecting appropriate eye protectors:

a) The nature of the hazards and risks to the eyes. For a combination of hazards more than one eye protector may be needed e.g. welding goggles and a suitable faceshield.

b) The condition under which the operator is working. In particular, working in confined spaces may give rise to reflected hazards, requiring sideways and rearwards protection.

c) The visual requirements of the task.

d) The condition of the operator's eyesight.

e) The appropriateness of the frame as a safety frame.

f) The personal preference of the wearer for particular safety frames. Comfort plus appearance are usually the main factors in wearer preference. Lightness, ventilation and unrestricted vision are important considerations.

Table 4.1[3] and 4.2[4] show what eye protectors and control measures to use for a given hazard. Section 5 outlines requirements to protect against UV such as:

- ensure the eye is protected against invisible radiation—UV and Infrared—and reduce exposure from visible radiation to comfortable levels; or
- fit helmets or handshields with filters of Shade Numbers of 7-15 inclusive (see *AS 1338.1:1992* for more information on these Shade Numbers).

For processes where only UV is a hazard (e.g. photographic reproduction work) eye protectors should have filters complying with *AS 1338.2:1992.*

<u>AS 1338.1:1992</u>

This Standard outlines requirements for eye protector filters used in welding and allied operations. Filters meeting this standard will protect against the high intensity radiation emitted during these processes. The *AS/NZS 1336:1997* recommends filters with Shade Numbers 7-15 to protect against UV during arc welding or cutting operations. Use *AS 1338.1:1992* to find out more about what these Shade Numbers mean and what is required.

<u>AS 1338.2:1992</u>

AS 1338.2:1992 has requirements for protecting against UV e.g. those required during photographic reproduction work. As for *AS 1338.1:1992*, it also indicates what criteria filters have to meet to be assigned a particular shade number.

[3] pp.15-16 of AS/NZS 1336:1997.
[4] pp.16-19 of AS/NZS 1336:1997.

AS/NZS 1337

This standard applies to all eye protectors used in industrial applications and outlines overall requirements such as:

- how handshields should be assembled; and
- how thick safety spectacles or goggles should be.

Eye protectors that meet this standard will have good UV protection. To comply with the Standard, the following information must be etched or impressed into the eye protector:

- The manufacturer's name, trade name or mark.
- The appropriate lens marking as given in Section 2 of the Standard and, where applicable, the appropriate marking as prescribed in AS/NZS 1338, Part 2 or Part 3.
- The appropriate marking as given in Table 3.2 of the Standard (copy shown below in Table 7).

Where the design of the eye protector is such that the lenses are integral to the frame or front frame the above information may be etched or impressed into the frame instead.

Table 7. Marking of Filters

Type of filter	Filter Marking
General purpose low velocity impact	The letters 'HT' where the lens is heat-treated. The letters 'CT' where the lens is chemically toughened.
Medium velocity impact	As for general purpose low velocity impact and with the letter 'I'.
High velocity impact	The letter 'V'.
Hot solids and molten metal	The letter 'M'.

The following information must also be supplied with the eye protectors:

- The type of protector as given in Table 3.2 (a copy of Table 3.2. is given in Table 8 below).
- The appropriate marking as given in Table 3.3 (a copy of Table 3.3 is given in Table 9 below).

The information should be marked on the packaging, however alternative methods such as swing tags or adhesive labels may be used, provided that the required marking is readily visible and secured to the eye protector supplied.

Table 8. Marking of Assembled Eye Protectors and Packaging

Type of protector	Lends marking	Eye protector marking
Low impact	The letters 'HT' where the lens is heat tempered. The letters 'CT' where the lens is chemically tempered.	No requirements additional to Clause 3.5.1(a).
Medium impact	As for low impact and with the letter 'I'.	As for low impact and with the letter 'I'.
High impact	As for low impact and with the letter 'V'.	As for low impact and with the letter 'V'.
Molten metal and hot solids	As for low impact and with the letter 'M'.	As for low impact and with the letter 'M'.
Splashproof	As for low impact.	As for low impact and with the letter 'C'.
Dustproof	As for low impact.	As for low impact and with the letter 'D'.
Gastight	As for low impact.	As for low impact and with the letter 'G'.
Outdoor use, untinted	The letter 'O'.	As for low impact and with the letter 'O'.

Table 9. Marking of Packaging for Indoor or Outdoor Use Eye Protectors

Type of Lens	Required Marking
Untinted or laminated/double glazed	These eye protectors are intended for indoor use where no optical radiation hazards exist.
Outdoor untinted	These eye protectors are intended for indoor and outdoor use where no optical radiation hazards exist other than solar radiation. They are intended to provide adequate protection against ultraviolet radiation from the sun, but are not intended to provide protection against sun glare
Outdoor tinted	These eye protectors are intended for outdoor use where no optical radiation hazards exist other than solar radiation. They are intended to provide adequate protection against sun glare and ultraviolet radiation from the sun.

Other Protective features to look for—in addition to ensuring compliance with the Australian Standards outlined above—are Eye Protectors that:

- are close-fitting;
- cover as much of the eyes as possible;
- have a high EPF rating of 9 or 10; and
- are tinted.

Retailers, importers or distributors of sunglasses or protective eyewear must ensure they comply with the Standard. If they don't, they can be penalised under the Fair Trading Act of each jurisdiction.

Where can I find more information?

Table 10. Where to find more information on PPE

WEBSITE	WHAT IT SHOWS
Sunglasses	
ARPANSA www.arpansa.gov.au/radiationprotection/factsheets/is_Sunglasses.cfm www.arpansa.gov.au/uvrg/products.cfm#2	Benefits of wearing sunglasses and what to look for when getting a pair. Suppliers of sunglasses that have been UPF tested.
Sunsmart www.sunsmart.com.au/download.asp?RelatedLinkID=296	Benefits of wearing sunglasses and how UV damages the eyes.
Information on UPF	
ARPANSA www.arpansa.gov.au/Services/upf/index.cfm www.arpansa.gov.au/uvrg/index.cfm www.arpansa.gov.au/uvrg/products.cfm	What it is, how its tested and what garments or clothing rates high. What is UV resource guide, why is it used and what is contained in it. What products have been UPF tested, which companies sell these UPF-tested products.
Sunsmart www.sunsmart.com.au/download.asp?RelatedLinkID=285.	What is UPF and what to look when choosing high-rating UPF clothing.

Table 11. Where to Find Copies of Fair Trading/Trade Practices Act of Each Jurisdiction

Government	Website
Federal	www.austlii.edu.au/au/legis/cth/consol_act/tpa1974149/
NSW	www.austlii.edu.au/au/legis/nsw/consol_act/fta1987117/
VIC	www.austlii.edu.au/au/legis/vic/consol_act/fta1999117/
SA	www.austlii.edu.au/au/legis/sa/consol_act/fta1987117/
WA	www.austlii.edu.au/au/legis/wa/consol_act/fta1987117/
TAS	www.austlii.edu.au/au/legis/tas/consol_act/fta1990117/
QLD	www.austlii.edu.au/au/legis/qld/consol_act/fta1989117/
ACT	www.austlii.edu.au/au/legis/act/consol_act/fta1992117/
NT	www.austlii.edu.au/au/legis/nt/consol_act/caafta286/

What to watch out for—Secondary Hazards

When implementing Control Measures, beware of Secondary Hazards such as:

- fire hazards created by some shielding (e.g. material or canvas) that protects well against UV;
- unventilated protective clothing (clothes that don't breathe) causing heat-stress during heavy manual labour;
- projectiles, sparks or chemical hazards that sunglasses or fashion spectacles (even those tested to *AS/NZS 1067: 2003* or with an EPF rating of 10) do not provide sufficient protection against;
- heat or visible light transmission through polycarbonate, fibreglass and clear/tinted plastic which blocks UV, but allows the heat in.

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