STANDARD OPERATING PROCEDURE

SAFETY Everyone. Everywhere. Every day

RADIATION AND LASER SAFETY

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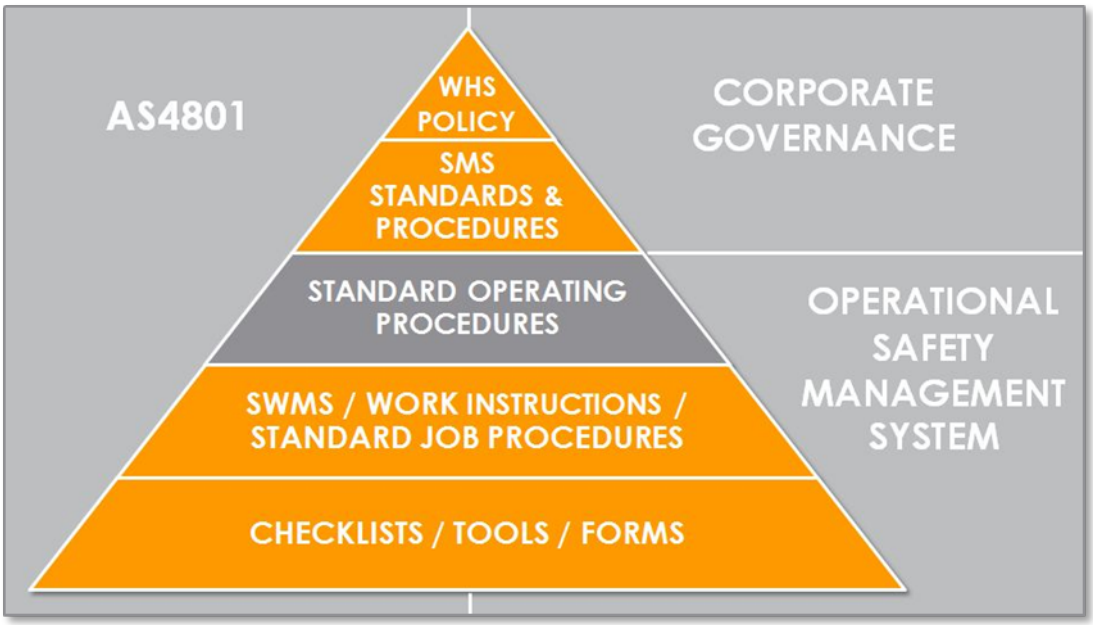
1. SMS DOCUMENT HIERARCHY



2. PURPOSE

This Standard Operating Procedure (SOP) documents Queensland Urban Utilities' (QUU) approach to the safe use of ionising and non-ionising radiation (referred to collectively in this SOP as 'radiation') and laser equipment. The overall purpose of this procedure is to ensure that risks associated with radiation and lasers are adequately managed in order to minimise the risk of injury or harm to workers.

3. SCOPE

This SOP provides practical guidance on how to manage health and safety risks associated radiation and lasers. This procedure applies to all QUU staff, including contractors and other persons on QUU-controlled worksites.

4. DEFINITIONS AND ACRONYMS

Dose Badge: is a device worn on a person that can measure exposure to ionising radiation. The badge contains a film or other substance that absorbs ionising radiation and can be later measured using a specific device by a qualified person.

Hierarchy of Controls: the ways of controlling the risk of MSDs are ranked from the highest level of protection and reliability to the lowest. This ranking is known as the hierarchy of risk control.

HSR - acronym used for Health and Safety Representative.

Ionising Radiation: is electromagnetic or particulate radiation capable of producing ions, but does not include electromagnetic radiation of a wavelength greater than 100 nanometres. Ionising radiation has enough energy to strip electrons and disrupt cellular activity at a molecular level.

Laser: Light Amplification by Stimulated Emission of Radiation which is the process by which lasers generate visible, ultraviolet (UVR) or infrared (IR) emissions.

Manager: as per QUU naming conventions, the Manager who has direct responsibility for the activity being performed or the area the activity is occurring in.

Non-ionising Radiation: is electromagnetic radiation of a wavelength greater than 100 nanometres. Non-ionising radiation does not have enough energy to disrupt molecules at the atomic level and health effects (if any) are predominantly due to heating of tissue.

Officer: as per section 9 of the Corporations Act 2001 (Cth) is a person who makes, or participates in making decisions that affect the whole, or a substantial part, of the organisation's activities. Specific to QUU, a QUU officer has been defined as Board Members; Chief Executive Officer (CEO); Executive Leadership Team Members; Operational General Managers.

RFR: acronym used for Radiofrequency Radiation

RSO: acronym used for Radiation Safety Officer

SMS: acronym used for QUU's Safety Management System.

SOP: acronym used for Standard Operating Procedure

STP: acronym used for Sewerage Treatment Plant.

Supervisor: term used for any QUU employee who acts or is appointed as a Supervisor, Coordinator or Team Leader within QUU.

WHS: acronym used for Work Health and Safety.

Worker: employees, contractors, subcontractors, outworkers, apprentices and trainees, work experience students, volunteers and PCBUs who are individuals if they perform work for the business.

5. ROLES AND RESPONSIBILITIES

Outlined below are responsibilities specific to radiation at all QUU workplaces and controlled sites.

5.1 QUU EXECUTIVE

QUU Executive and Senior Management (CEO, ELT, General Managers – Officer and Non-Officer Appointed) are responsible for overseeing and ensuring the implementation of the requirements of this SOP and related procedures within their respective functional areas. This includes ensuring all sites are suitably risk assessed and have appropriate facilities, services and resources to ensure that risks associated with radiation and lasers are adequately managed to minimise the risk of injury or harm to workers.

5.2 MANAGERS

Managers in all operational areas and QUU worksites are responsible for ensuring the review and management of risks associated with radiation and lasers. This includes:

- Undertaking a radiation risk assessment in consultation with relevant local managers and supervisors to determine and ensure the resources required for the workplace or site are in place and appropriate to the layout, tasks, hazards and risks in that area;
- Monitoring and ensuring all contractors who undertake work for or on behalf of QUU have implemented safe radiation and laser practices in accordance with this SOP and relevant legislation and Codes of Practice;
- Ensuring all relevant workers who are at potential risk of radiation exposure are aware of this Radiation & Laser SOP and have access to appropriate resources;
- Monitoring and ensuring that radiation and laser training details are recorded and kept up to date in the QUU's My Learning Space (MLS); and
- Monitoring and following up any and all control measures that are implemented for laser hazards to ensure effectiveness of controls and to ensure other risks are not created.

5.3 SUPERVISORS/PICOW

Supervisors and Team Leaders in all operational areas and QUU worksites are responsible for ensuring that risks associated with radiation and laser are managed including:

- All workers and contractors are trained in the safe use of any radiation generating equipment and lasers on site;

- A laser risk assessment has been completed for the site;
- Known radiation and laser hazards are included in the local site induction; and
- All workers and contractors are aware and comply with the requirements of this SOP.

5.4 RADIATION SAFETY OFFICER

QUU Radiation Safety Officers are responsible for the following:

- Ensuring a radiation risk assessment has been completed for the site;
- Providing instruction to contractors relating to work being conducted within the radiation exclusion zone;
- Managing the issuing and analysis of dose badges and notifying relevant QUU Management of high readings;
- Ensuring adequate resourcing is provided to control risks and ensure appropriate PPE is available, accessible and known by workers; and
- Monitoring and following up any and all control measures that are implemented for radiation and laser hazards to ensure effectiveness of controls and to ensure additional risks are not created.

5.5 WORKERS

All workers shall ensure that they:

- Follow the guidelines of this Radiation & Laser SOP and related procedures;
- Use equipment that is provided for radiation and laser safety as instructed by QUU;
- Report any defects with PPE and equipment that generates radiation or laser light to their supervisor; and
- Report any radiation and laser related incidents/injuries immediately to their supervisor; and
    - Follow QUU's **Health Management Procedure (PRO367)**; and
    - Complete a QUU WHS Incident Report (in QPulse) in accordance with QUU WHS incident reporting procedures.

5.6 CONTRACTORS

At all times when performing work on a QUU site or for/on behalf of QUU, contractors must comply with QUU's radiation and laser safety management requirements detailed in this and related procedures and report any radiation or laser related incidents to the relevant QUU Manager and to their employing / contracting agency in accordance with QUU WHS incident reporting procedures.

6. RELATED DOCUMENTS

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- WHS Hazard and Risk Management Procedure (PRO363)
- WHS Incident Reporting, Investigation and Escalation Procedure (PRO364)
- WHS Audit and Inspections Procedure (PRO366)
- Health Management Procedure (PRO367)
- Radiation Risk Assessment Form (pro446)

7. PROCEDURE

7.1 OVERVIEW

Workers can be exposed to radiation from a variety of natural and artificial sources. Radiation is energy travelling as waves or particles. Ionising radiation has enough energy to change the chemical composition of matter. Non-ionising radiation has less energy but can still excite molecules and atoms causing then to vibrate faster. Laser light is a form of non-ionising radiation that has specific risks to

health and must also be controlled. It is the aim of this SOP to assist QUU workers and contractors to identify, assess, control and review radiation sources and laser in order to prevent injuries at work.

7.2 IONISING RADIATION SOURCES

Industrial gauges that incorporate radioactive substances are used for a variety of manufacturing process and quality control applications. These applications may include the non-invasive measurement and control of the thickness, level, density, weight, moisture content or chemical composition of an item or material in an industrial production process. The principle of operation depends on the detection of radiation that is transmitted through, scattered by, or is the resultant secondary emission produced from within, the item or material of interest.

The radioactive substances incorporated in industrial gauges are generally of a level of activity that would, if not adequately shielded, result in a significant health hazard. Unauthorised persons must not remove, or in any way interfere with, the radioactive substances or carry out any maintenance, adjustment or modifications to radiation gauges. In Queensland, the personal radiation monitoring results of persons employed where industrial gauging takes place indicate that radiation doses above 1mSv per year are seldom received. By comparison, the annual average natural background radiation dose to a person is 2mSv per year. However, a significant radiation dose can be received as a result of poor work practices or if equipment does not comply with the relevant standards.

In QUU, there is currently one work place, Oxley Creek STP, that uses instrumentation with an ionising radiation source. The units are located near the top of the three reactor tanks of the CAMBI system (Level 1), where the radiation passes through the reactor tanks to radiation detectors. In order to satisfy Queensland State regulations, QUU holds a licence to possess industrial gauges. In so doing, QUU have demonstrated to the Chief Executive of Queensland Health that all of the radiation safety criteria set by the *Radiation Safety Act 1999* have been satisfied.

7.2.1 RADIATION SAFETY AND PROTECTION PLAN

The *Radiation Safety Act 1999* requires that a radiation safety and protection plan be developed where sealed source apparatus industrial gauging practices are conducted. For this reason, QUU has developed *MP72 Radiation Safety and Protection Plan for Oxley Creek STP*. All workers and contractors working at Oxley Creek STP, who are required to carry out the industrial gauging practice, must be familiar with this plan. The plan details how to safely manage sealed source apparatus including:

- Safe work practices with respect to handling, storage and transport;
- Repair and maintenance;
- Radiation monitoring devices;
- Routine safety checks;
- Acquisition, supply, storage, relocation and disposal of radioactive substances;
- Incident notification; and
- Record keeping.

Any other QUU sites that are required to obtain or install a sealed ionising radiation source instrument will develop a Radiation Safety and Protection Plan. This must be submitted to the Chief Executive of Queensland Health. As a licensee holder, QUU must comply with the responsibilities as per Section 3 of *MP72 Radiation Safety and Protection Plan for Oxley Creek STP*. Some of these criteria are summarised below.

QUU, as a possession licensee will:

- Hold a licence, issued under the *Radiation Safety Act 1999*, with an authority to possess sealed radioactive substances incorporated in industrial gauges;
- Manage radiation doses arising from the radiation practice are kept below the limits specified in the *Radiation Safety Regulation 2010* and are as low as reasonably achievable;
- Provide personal monitoring devices to monitored persons as required, and ensure that:
    - Personal monitoring devices are handled properly;

- Monitored persons are advised of their personal monitoring assessment results; and
- Copies of the personal monitoring assessment results are submitted to the Chief Executive of Queensland Health;

- Achieve compliance with any conditions imposed on the possession licensee by the Chief Executive, Queensland Health and with those stated in the *Radiation Safety Act 1999* and the *Radiation Safety Regulation 2010*;
- Implement the version of the radiation safety and protection plan being used has been approved by the Chief Executive, Queensland Health;
- Appoint a radiation safety officer certified under the *Radiation Safety Act 1999*;
- Provide adequate resources are provided to implement this radiation safety and protection plan (e.g. provision of appropriate training in radiation safety, radiation monitoring devices etc.);
- Ensure that the industrial gauges continue to comply with radiation safety standard *NM009:2010 Standard For Sealed Radioactive Substances Incorporated In Sealed Source Apparatus Used To Carry Out Industrial Gauging*, and obtain certificates of compliance from an appropriately accredited person before initial use and every three years thereafter;
- If there has been a change in the location of a gauge, an appropriately accredited person must perform an assessment of the premises for compliance with radiation safety standard PR100:2010 - *Ionizing Radiation Sources* before the gauge is used;
- Obtain approval from the Chief Executive of Queensland Health before disposing of radioactive material greater than the amount and concentration prescribed in the *Radiation Safety Regulation 2010*; and
- Immediately notify the Chief Executive of Queensland Health after an incident, either verbally or in writing. If the notice is given verbally, written confirmation must be provided within seven (7) days.

7.2.2 RADIATION SAFETY OFFICER

As a possession licensee who possesses a radiation source for a radiation practice, QUU must appoint a Radiation Safety Officer (RSO) under the *Radiation Safety Act 1999*. Only a qualified person who holds a Radiation Safety Officer Certificate relevant to a radiation practice may be appointed as an RSO for QUU. The functions of the RSO are to:

- Identify ways, consistent with the plan, of minimising the radiation doses received by persons from the source;
- Provide, or arrange for the provision of, training about radiation hazards and safe working practices to:
  - persons carrying out the practice; and
  - the licensee's employees and other persons working for the licensee who may be exposed to radiation emitted from the source; and
  - Other persons prescribed under a regulation.
- Provide, or arrange for the provision of, training to the about precautions that need to be taken to ensure radiation doses received by the persons and other persons from the source, are:
  - for ionising radiation: below the radiation dose limit prescribed under a regulation and as low as reasonably achievable; or
  - For non-ionising radiation: below the radiation dose limit prescribed under a regulation and minimised as far as is practicable.
- Identify whether the plan is being complied with;
- Regularly review the plan to ensure its continued effectiveness; and

- Identify whether the relevant radiation safety standard for the source, or premises at which the practice is being carried out, is being complied with.

QUU appointed RSOs will be provided with training relevant to industrial gauging ionisation sources through a Queensland Government approved training provider and will be issued with a RSO Certificate from Queensland Health. All costs associated with training and certification will be met by QUU.

7.2.3 MAINTENANCE

When maintenance works are to be performed the following will occur:

- The Radiation Safety Officer will provide a site specific induction with the contractors. The contractors will have relevant qualifications to undertake maintenance work. This also includes advising contractors that whilst the CAMBI is de-energised the source remains energised;
- The Radiation Safety Officer will lock out and tag out, including de-energising, the CAMBI prior to any maintenance works occurring;
- The Radiation Safety Officer will undertake radiation readings. These reading will occur at contact and at 1 metre; and
- The Radiation Safety Officer will remove all locks and re-energise the CAMBI at the end of the maintenance period.

7.2.4 DISMANTLING PLANT

If the CAMBI or related equipment needs to be dismantled, the following must occur:

- All items must be stored in the bunker and records of stored items kept with the Radiation Safety Officer; and
- Disposal of radiation sources must be undertaken by a suitably qualified contractor.

7.3 NON-IONISING RADIATION

Non-ionising radiation refers to any type of electromagnetic radiation that does not carry enough energy per quantum to ionise atoms or molecules. Near ultraviolet, visible light, infrared, microwave, radio waves, and low-frequency radio frequency (long-wave) are all examples of non-ionising radiation.

Typical examples of non-ionising radiation in QUU work sites include radiofrequency radiation (RFR) from mobile phone towers, mobile and cordless phones, Wi-Fi, radio-transmitters and ultraviolet (UV) sources including the Sun and UV lights (used for sterilisation in sewage treatment).

7.4 RADIOFREQUENCY RADIATION

RFR, which is used mainly for communications purposes, is the transfer of energy by radio waves. RFR lies in the frequency range between 3 kilohertz (kHz) to 300 gigahertz (GHz). For decades, researchers have been investigating RFR's effects on humans, animals and the environment. It is now well established that exposure to sufficiently high levels of RFR can heat biological tissue and potentially cause tissue damage. Damage occurs because the human body is unable to cope with the excessive heat generated by very high RFR exposure. Studies have shown that environmental levels of RFR routinely encountered by the public, however, are far below the levels needed to produce significant heating and increased body temperature.

At typical levels, mobile phone base station emissions are hundreds of times below the general public exposure limit of around 4.5 to10 watts per square metre, and are around 5000 times below the level where significant heating can occur. In the immediate vicinity of a mobile phone base station antenna (i.e. directly in front), the occupational exposure level will be exceeded, and for this reason, antennae are located above the level at which personnel can come into direct exposure of the RFR beam at close-range.

Some QUU reservoirs have RFR antennae on top. Where RFR-generating antennae are located in a workplace, the following will be implemented:

- A Radio-communications Site Management Book (RCSMB) will be developed by the telecommunications provider and a copy kept on site;
- The site will be registered with the Radio Frequency National Site Archive (RFNSA);

- The RCSMB will include a plan of the structure and will indicate where antennae beams are directed and where it is safe and unsafe for access of the public and maintenance workers;
- Antennae will be located so as to ensure full compliance with RFR exposure standards and to minimise unnecessary RFR exposure;
- Access to the site and antennae will be secured through the use of barricades, locks, perimeter fencing etc.; and
- Signage and ground markings will be installed to warn of RFR hazard zones and safe areas.

When QUU staff or contractors access areas where RFR-generating antennae are located, the following must be completed prior to undertaking works:

- Prior to performing work in and around an RFR-generating antennae area, a Working at Heights Permit must be completed. Additionally, in accordance with **Falls SOP – (PRO409)** a Safe Work Method Statement (SWMS3) must also be completed.
- Prior to accessing the upper level of a QUU reservoir that contains RFR equipment, all QUU staff and contractors must consult the RCSMB. Where access is required inside the transmitting zones (as defined in the RCSMB), the following will apply:
    - **Red Zone** *(areas above ARPANSA RPS3 Occupational Limits)*: no access without confirmed power reduction or transmitter shutdown;
    - **Yellow Zone** *(areas above ARPANSA RPS3 Public Limits)*: limited access to specially trained personnel (RF Workers); and
    - **White Zone** = General access allowed.

  Figure 1 below (of a QUU asset at Manly West in Brisbane) shows a typical diagrammatic representation of the hazard zones (red, yellow and white) of an RFR installation.

  An example of a generic Safe Work Procedure for RFR installations is given in **Appendix A.**
- Training must be provided to all QUU staff and contractors who are required to access areas where RFR generating equipment is located; and
- All hazards, risks and control measures associated with RFR on site must be included in the site-specific induction/prestart.

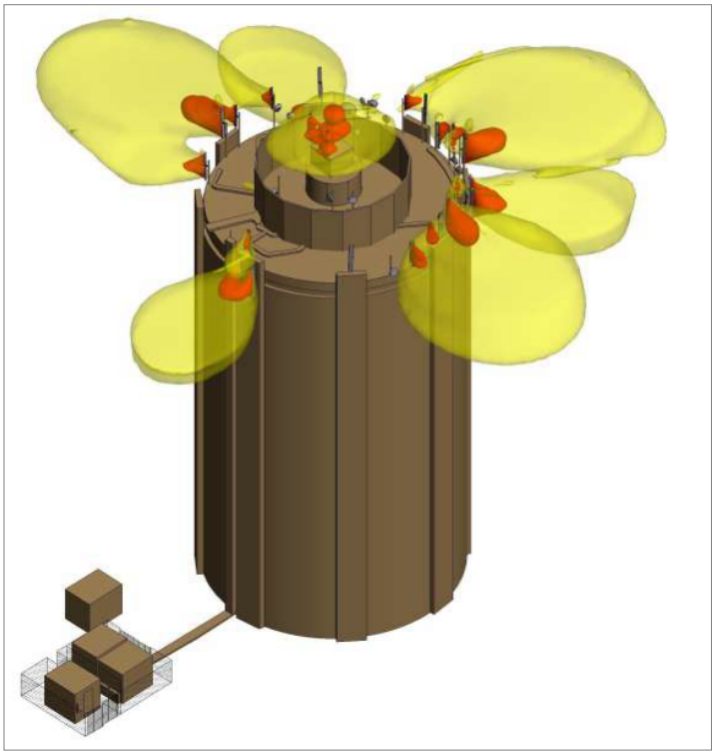

Figure 1: Transmitting Antennae Hazard Zones on Water Tower at Roles Hill Reservoir, Manly West.

7.5 UV RADIATION

UV radiation sources in the QUU workplace include the sun, welding arc, UV sterilisers used in some STPs, and some laboratory processes (such as UV germicidal lamps and transilluminators). Exposure to UV radiation can cause skin burns, corneal/retinal damage and cancer.

To avoid exposure to UV radiation workers need to be shielded from UV radiation sources, and control measures need to be put in place.

- **Sun:** For control measures against UV exposure from the sun, refer to **Hot & Cold Environments SOP (PRO423)**.
- **Welding:** the arc created when welding with electric arcs or lasers emits UV, infrared and visible light radiation. Eye disorders and skin burns may be caused by exposure to intense ultraviolet and infra-red radiation in welding. Refer to the **Welding SOP (PRO439)** for safe welding practices.
- **UV Sterilisers**: Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses UV light at a short wavelength to kill microorganisms. It is used in a variety of applications, such as food, air and water purification. UVGI utilises short-wavelength ultraviolet radiation (UV-C) that is harmful to microorganisms. It is effective in destroying the nucleic acids in these organisms so that their DNA is disrupted by the UV radiation, leaving them unable to perform vital cellular functions. A UVGI system is designed to expose environments such as water tanks, sealed rooms and forced air systems to germicidal UV. Exposure comes from germicidal lamps that emit germicidal UV electromagnetic radiation at the correct wavelength, thus irradiating the environment.

  This method of sterilisation is used in the out-flow of some STPs as well as in some air handling units. The forced flow of air or water through this environment ensures the exposure. To prevent exposure to QUU staff and contractors, all UVGI systems will operate in an environment that is isolated from persons, fully shields the UV source and features an interlocked power source such that opening the enclosure will shut down power to the UV lamps. Additional controls that will be implemented in QUU work places to prevent exposure to UV radiation from lamps include:

  - Written work instructions for specific UV generating equipment;
  - Training of all workers in the safe use of all UV generating equipment including lamps and hand-held devices used in laboratories;
  - Labelling of all UV generating equipment warning that there is a UV radiation hazard, shielding must be in place when operating the equipment, and eye/skin protection is needed for operation; and
  - PPE will be worn when using UV lamps and hand-held devices and will include long sleeves, gloves, and face shields designed to protect against the UV wavelength generated. All skin must be covered.

7.6 LASERS

The word laser is an acronym for Light Amplification by Stimulated Emission of Radiation, which describes the process by which lasers generate visible, ultraviolet or infrared (IR) emissions.

The light produced by a laser has very different properties to that produced by other sources (such as the sun, light bulbs or fluorescent/neon tubes). Laser light is monochromatic (a single wavelength) and typically confined to a narrow beam which spreads only slightly with distance. Thus the energy carried by a laser beam is concentrated in a small area and can travel efficiently over large distances, giving laser radiation a far greater potential to cause injury than light from other sources.

7.6.1 LASER CLASSIFICATION

Lasers are classified according to the hazard associated with their emissions, as defined in the Australian/New Zealand Standard *AS/NZS IEC 60825.1:2011 Safety of Laser Products Part 1: Equipment Classification and Requirements* and *AS/NZS IEC 60825.14:2011 Safety of Laser Products Part 14: A User's Guide*:

- **Class 1 and 1M lasers** are safe under reasonably foreseeable conditions of operation. Class 1M can be hazardous if the beam is viewed with magnifying optical instruments (hence the letter 'M' is added).

- **Class 2 and 2M lasers** emit visible light at higher levels than Class 1, but eye protection is provided by aversion responses such as the human blink reflex. Class 2M lasers can be hazardous if the beam is viewed directly with magnifying optical instruments.
- **Class 3 lasers** are medium-power lasers that pose a modest potential for injury. Class 3 laser users may be required to follow specific safety precautions and may require the wearing of safety equipment such as laser protective eye wear. Skin hazards normally do not exist for incidental exposures. Three Class 3 subcategories exist:
    - **A Class 3A laser** emits higher levels of radiation and requires more stringent precautions than those necessary for Class 2 laser products. They differ from Class 2 laser products in that they emit more power in a beam of larger cross-section, so that when the output is viewed directly, the power of the beam entering the eye does not exceed that of a Class 2 laser product. However, if the beam is viewed through larger diameter collecting optics (e.g. binoculars) then the hazard is usually increased. For continuous wave (CW) output in the visible wavelength range, the output power from Class 3A lasers is limited to 5mW and the maximum irradiance (power density) is 25W.m^{-2}.
    - **Class 3B (Restricted) lasers** or laser systems operate at the same power levels as Class 3A but have higher levels (25 to 50W.m-2) of irradiance. They may be used in daylight conditions under the same controls as for Class 3A laser products. Where used in conditions of less illuminance (generally less than 10 lux), the appropriate safety controls are those specified for Class 3B laser products.
    - **Class 3B lasers** can emit either invisible or visible radiation and direct viewing is hazardous to the eye. Class 3B lasers are capable of causing eye injury either because their output is invisible and therefore aversion responses are not activated, or because the beam power is such that damage is done in a time shorter than the blink reflex (0.25s). Higher power lasers in this class may also cause skin burns. However, with laser wavelengths other than those in the ultraviolet region, the pain produced by rapid heating of the skin will usually evoke an aversion response sufficient to avoid such burns.
- **Class 4** lasers are high power devices capable of causing both eye and skin burns. Their diffuse reflections may also be hazardous and the beam may constitute a fire hazard.

7.6.2 HAZARDS AND CONTROLS FOR LASERS

The eyes and skin are the organs primarily at risk from exposure to laser light. Health effects from exposure to laser light are generally divided into two categories: radiation and non-radiation hazards.

Radiation hazards include injury to the eyes and skin from direct exposure to the laser beam or any reflections. Momentary viewing of the beam from a Class 2 laser may cause temporary flash-blindness, similar in effect to viewing a photographic flash at close range. However, unlike the photographic flash, a Class 2 laser can cause flash-blindness up to 50 metres or more.

The factors that can contribute to tissue injury and influence the degree of damage from laser beam exposures include:

- Wavelength of laser radiation;
- Tissue spectral absorption, reflection and transmission;
- Strength of irradiance of incident laser beam;
- Size of irradiated area;
- Exposure duration;
- Pupil size;
- Location of retinal injury; and
- Laser pulse characteristics.

Depending on wavelength, eye damage of the cornea, of the retina, or of both, is possible. Exposure to radiation from a CO_2 laser (10.6 µm) typically results in corneal damage. The radiation from an Nd:YAG laser, at 1.06 µm, is much closer to the visible spectrum (400 to 700 nm) and can be transmitted by the

cornea and lens. The lens will focus the laser light on the retina, causing severe and permanent damage to the retina and other intraocular material and tissue.

Eye Protection

Information on eye protectors suitable for use with particular lasers and operations together with their required marking is given in *BS EN207 Personal Eye-Protection: Filters and Eye-Protectors against Laser Radiation (Laser Eye Protectors)* and *BS EN208 Personal Eye-Protection: Eye-Protectors for Adjustment Work on Lasers and Laser Systems (Laser Adjustment Eye-Protectors)*.

The following must be considered when specifying suitable protective eyewear:

- Wavelength(s) of operation;
- Radiant exposure or irradiance;
- Maximum permissible exposure (MPE);
- Optical density of eyewear at laser output wavelength;
- Visible light transmission;
- Radiant exposure or irradiance at which damage to eyewear occurs;
- Need for prescription glasses;
- Comfort and ventilation;
- Degradation or modification of absorbing media, even if temporary or transient;
- Strength of materials (resistance to shock);
- Peripheral vision requirements; and
- Any relevant legislation.

A method of selecting the laser or laser adjustment eye protector most suited to the hazards associated with the use of a particular laser is given in *AS/NZS 1336; Recommended Practices for Occupational Eye Protection*.

Special attention must be given to the protection and stability against laser radiation when choosing eyewear for Class 4 laser products. Laser eye protectors and laser adjustment eye protectors which have been damaged or have undergone a colour change must not be used. Eye protectors are only intended to protect against accidental exposure as the ratings are based on a maximum exposure of 10s (for a continuous wave laser) or 100 pulses (for a pulsed laser). Eye protectors are not intended to be used for looking directly into the beam.

A precaution must be added here – standard safety glasses alone do not provide protection. Any laser eyewear, plain or prescription, must be labelled in accordance with *BS EN207* or *BS EN208* with information adequate to ensure the proper choice of eyewear with particular lasers. In some laser systems, ultraviolet light may be leaked into the workplace. Thus the eyewear must provide primary beam protection, secondary radiation protection and also ultraviolet protection.

Skin Protection

Where employees and other persons on QUU-controlled worksites may be exposed to levels of radiation that exceed the MPE for the skin, suitable clothing must be worn.

Class 4 laser products present a potential fire hazard and protective clothing worn must be made from a suitable flame and heat-resisting material. Special attention must be given to resistance and long-term stability against laser radiation when choosing protective clothing for use with Class 4 laser products.

Electrical Hazards

The voltages used in lasers are sufficient to cause fatal injuries to personnel and account for most laser-related fatalities. All electrical equipment associated with laser beam materials processing must be installed in conformance to *AS/NZS 3000 Electrical installations* (known as the Australian / New Zealand Wiring Rules).

All doors and access panels must be properly secured, either electrically or mechanically, to prevent access by unauthorised personnel to electrical components, especially those operating at the laser excitation potential.

All employees and other persons on QUU worksites working on or around high-voltage components must be trained in the proper safety techniques for electrical systems, as well as in the technique of removing a victim from an electrical circuit and administering cardiopulmonary resuscitation (CPR). Personnel must be aware of and adhere to any additional electrical safety requirements of the laser system installed in their facility.

Usually, the best source of safety information is provided in the instruction manual from the manufacturer of the laser system. Always read, understand and follow the manufacturer's recommended safety procedures.

Fumes and Gases

Welding, cutting and drilling, and surface modification with lasers may result in the generation of fumes, dust, and gases that can be hazardous to personnel.

These airborne contaminants may include:

- Vaporised target material and reaction products in the form of metal particles and oxides;
- Gases from the flowing gas laser systems or from the by-products of laser reactions, such as ozone, nitrous oxide, carbon monoxide and carbon dioxide;
- Gases or vapours from cryogenic coolants; and
- Gases used to assist laser-target interactions, such as oxygen.

The hazards associated with welding and cutting of metals have been documented in a variety of publications including the WTIA Fume Minimisation Guidelines. It should be noted that some organic materials, such as plastics, can generate fumes that are hazardous. Care must be taken to avoid the excessive build-up of laser discharge gases, shielding gases, and assist gases, especially in enclosed spaces where oxygen can be displaced.

All necessary environmental engineering measures for fume and gas control (external venting, filtering, etc.) must be taken to prevent the accidental inhalation of harmful concentrations of fumes and gases by personnel working on or around laser materials processing equipment.

Exhaust of these fumes may violate local or federal standards, and implications must be considered before using equipment. The possible toxicity of the work-piece and consumables (wire, powder, etc.) must be determined before laser-beam material processing begins.

Adequate protection to personnel must be provided – refer to *WTIA Technical Note 7 Health and Safety in Welding* and the *WTIA Fume Minimisation Guidelines*. Also, for all materials, the Safety Data Sheet (SDS), available from the material supplier, must be consulted to determine what hazards exist.

Fire Hazard

Since the laser system produces a very small spot size with high energy, the hazard of fire is present if the beam hits flammable material. Flammables must be kept away from the welding or cutting area. All flammable items in the area must be covered and protected, as reflected radiation could start fires in unexpected areas.

The potential for explosions at the capacitor bank or optical pump systems exists during the operation of some high-power laser systems. Metallic and non-metallic dusts such as airborne particles coming from the target area in the laser cutting, drilling and welding operations may be capable of causing fire or explosion. Explosive reactions of chemical laser reagents or other chemicals or gases are also possible.

Secondary Radiation Hazards

Viewing of the visible radiation emitted during laser materials processing can also be harmful to eyesight. During welding, a bright plume, similar in appearance to a welding arc, is generated from the interaction between the laser beam and material being processed. The size and intensity of this plume is a function of the material being processed, the power level, and the shielding gas used. Consequently, no exact guidelines can be given. However, the radiation emitted is broad-spectrum, ranging from ultraviolet,

which can cause sunburn and arc-eye, through the visible spectrum to infrared, which can contribute to the formation of cataracts.

As the plume is generally too bright for direct viewing, adequate filtering, such as welding shades, must be employed for eye protection. As a general guideline, the filter used must be of sufficient optical density to ensure the viewer's comfort at the highest level of light intensity encountered and there must be no evidence of eye irritation after exposure. The optical viewing system must provide filtering in conformance to AS/NZS 1337 and 1338 and must include provisions for filtering the visible and ultraviolet radiation from the plume as well as the laser radiation.

All persons involved with laser beam materials processing must be instructed in the use of proper optical filtering and are required to use such protection as part of their PPE.

7.6.3 LASER USE AT QUU

Class 1, 2, 3A, 3B (Restricted) Lasers

Use of lasers at QUU is typically in profiling levelling and measurement applications, including surveying. Laser scanners are also used in office and stores applications. Laser pointers may be used in meetings, lectures and seminars. These lasers are normally class 1or 2 lasers, emitting a maximum power output of less than 1 milliwatt, and do not represent a significant risk to health.[1]

Workers using measurement, levelling or surveying lasers outdoors must wear standard UV protective safety glasses.

Construction lasers range between Class 1 and 3 (A and B Restricted), and may have an invisible beam or a coloured beam (typically red). Precautions must be followed when construction lasers are being used. These include:

- All operators must be trained in accordance with *Australian Standard AS2397: 1993 Safe Use Of Lasers in the Building and Construction Industry*;
- A Laser Safety Officer (LSO) must be appointed at the worksite (only for Class 3 [A,B Restricted and B] and Class 4).
- A copy of *AS2397 - 1993* must be kept on work sites operating lasers at all times;
- They must not be used in dimly lit environments; and
- The level of natural illumination must be above 100 lux or not low enough to cause the pupil to dilate in excess of 5 mm in diameter (this is to limit the amount of energy that could enter the eye.

Class 4 Lasers

QUU does not currently use Class 4 lasers. However, should the use of Class 4 lasers be required, the advice provided in this SOP must be followed.

Class 4 lasers are high-power lasers that pose a serious potential for injury of the eye and skin and require that users follow specific safety precautions and wear laser protective eyewear. Class 4 lasers are primarily used in medicine and will not generally be seen in the utilities industry. Refer to Section 7.6.2 for suitable controls.

7.6.4 HEALTH MONITORING

QUU employees and other persons using lasers on QUU-controlled worksites whose work involves a significant risk of exposure to laser radiation in excess of the Maximum Permissible Exposure (MPE) must have eye examinations and, where appropriate, skin examinations carried out before commencement and after termination of the job. For anyone at increased risk of laser damage, more frequent eye examinations may be advisable. (Health monitoring of operators using lasers of Class 3B or less is not a requirement of AS 2397).

[1] Only purchase laser pointers from a reputable source as some models from overseas have a higher class rating than indicated on the device and can cause eye damage if misused.

7.6.5 CALIBRATION OF LASER EQUIPMENT

Lasers used at QUU work sites must be calibrated at intervals recommended on the laser device and instruments that are outside of calibration date must be tagged 'out of service' until calibration can be verified.

7.6.6 LASER SAFETY OFFICER

The Laser Safety Officer (LSO) is defined in AS/NZS 2211.1 as "one who is competent in the evaluation and control of laser hazards and has responsibility for oversight of the control of laser hazards". Any worker or contractor operating or using a class of Laser identified as requiring an LSO as outlined in the Australian Standard must appoint an LSO.

7.7 DOCUMENTATION AND RECORD KEEPING

A copy of all Radiation and Laser records (i.e. completed Radiation and Laser Risk Assessments, Health Monitoring results) must be held in TRIM with physical hard-copies securely kept / held at site in a manner that affords confidentiality (where required), easily accessible for audit and review purposes.

8. REFERENCES

The following references contain information used in the preparation and development of this Radiation & Laser SOP:

- *Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)*
- *Queensland Work Health and Safety Act 2011*
- *Queensland Work Health and Safety Regulations 2011*
- *Queensland Managing Risks of Plant in the Workplace Code Of Practice 2013*
- *Radiation Safety Act 1999*
- *Radiation Safety Regulation 2010*
- *Radiation Safety Standard PR001:1999 Standard for Premises At Which Radiation Sources Are Used to Carry Out a Radiation Practice*
- *Radiation Safety Standard PR002:1999 Standard for Premises At Which Radiation Sources Are Stored*
- *National Health & Medical Research Council, Recommendations For Limiting Exposure To Ionizing Radiation (1995)*
- *National Health & Medical Research Council, Recommended Limits On Radioactive Contamination On Surfaces (1995)*
- *AS 2397-1993 Safe Use of Lasers in the Building and Construction Industry*.

9. REVIEW

The Radiation SOP is to be reviewed every 3 years or earlier if:

- There is an identified risk to business;
- A significant safety or serious injury event occurs;
- Incident investigation or audit results show that application of the standard fails to deliver the required outcomes;
- There are changes in associated legislation; or
- There is evidence that the standard is not having a positive impact on safety-related KPIs.

10. FURTHER INFORMATION

For further information, contact your Health and Safety Representative or the QUU Safety Team.

APPENDIX A – GENERIC RADIO FREQUENCY RADIATION SAFE WORK PROCEDURE

The following table is a summary of generic safety procedures for work on radio frequency transmitter sites. Always confirm site specific and QUU safe operating procedures.

No	Procedure	Summary
1	**Safe Work Procedure** Read the site RF safety documentation *Radio Communications Site Management Book"* (RCSMB)	Locate & read RCSMB and confirm latest version • check NSA for latest update or contact Site RF Manager • identify restricted access & RF hazard areas • identify equipment, plant & codes involved • verify safety procedures in RCSMB with all personnel • contact Site RF Manager for any questions • Do not enter restricted areas with out power down
2	**Interim Safe Work Instructions**	If RCSMB Incomplete / not updated or not available • check NSA for latest update • contact Site RF Manager • Use personal RF monitor to verify safe working conditions at all times
3	**Locate Relevant Plant**	Locate the following plant: • antennas • feeders or transmission line • switches or splitters • transmitters
4	**Match plant Codes**	Physically check feeder & antenna codes
5	**De-Energised Plant** Transmitter switch-off must be verified by use of RF radiation meter or Personal RF monitor	De-energise transmitter when required using • key-interlock • power diversion • isolation • earthing Break or isolate feeder at designated feeder opening point
6	**Use DO NOT ALTER Signs** (where supplied)	When equipment has a temporary status for safety purposes • attach sign to relevant equipment • mark & log entry on sign • Check sign status after change of shift
7	**Pass-Through Procedure** (Broadcast Sites)	At broadcast sites, a transmitter power reduction may be used to allow safe pass through of a designated area. Detailed procedure in section 3, "Site Access Control", of RCSMB. • switch-off and/or power reduction • Use personal RF monitor or RF radiation meter to verify power reduction • Confirm switch-off and/or power reduction with personnel at transmitter • Confirm safe working conditions • Pass through designated area
8	**Re-activation of Transmitter/s**	• Procedure is reversal of above ensure all staff have moved to safe area