

# Radiation Management Plan

## Booklet 4 - Facilities & General Safety in Radiation Areas

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## 1. Overview of radiation facilities at Charles Sturt University

Charles Sturt University as a regional university distributed across several campus locations engages in the use of a range of teaching and research activities using ionising radiation. Radiation facilities include general x-ray and mobile x-ray apparatus for diagnostic radiography; intraoral and panoramic x-ray units for dental radiography; general x-ray and computed tomography for animal radiography in the veterinary sciences. The university also has facilities for the use of sealed and unsealed radiation source radiative sources to include neutron probes (sealed source) used for environmental and agricultural research.

## 2. General safety in laboratories and radiation areas

### 1.1 General Working Rules for all X-Ray Units and Users

- a. Any person who uses an X-ray unit must avoid exposing any part of the body to a primary X-ray beam.
- b. No user shall allow the X-ray tube to remain energised unless all warning lights are operating correctly.
- c. No X-ray tube shall be energised:
  - 5.1.c.1. while outside its protective tube housing; or
  - 5.1.c.2. with an unshielded aperture in the tube head or protective barrier.
- d. No sample, collimator, monochromator, or analysing crystal shall be changed or adjusted while a primary X-ray beam passes through that collimator or is incident on that sample or crystal unless:
  - 5.1.d.1. the sample, collimator, monochromator, or crystal, during and after the change or adjustment, is within a shielded enclosure; and
  - 5.1.d.2. the change or adjustment is done by remote means from outside the enclosure.
- e. Immediate measures shall be taken to negate potentially hazardous situations arising from X-ray beams that may be emitted due to equipment defect, misalignment, or any other reason.

- f. A list of additional working rules shall be drawn up for each X-ray unit where necessary to ensure safety. This is of particular importance for units which do not meet the requirements of the ARPANSA (1984) Code for enclosed or partly enclosed units and will be determined by the RSC.
- g. Inexperienced persons must not perform the necessary operations of the X-ray equipment unless under direct supervision of an experienced and authorised operator.
- h. Alignments or adjustments shall not be carried out visually while the X-ray tube is energised, unless a viewing system is used which is shielded or designed to prevent exposure of the eye or other parts of the body to the primary beam.
- i. The X-ray unit shall not be operated, by inactivation of an interlock or with part of its enclosure removed, without prior approval of the statutory authority or unless the X-ray tube is wholly enclosed by the tube housing with all apertures completely covered by interlocked shutters and/or fixed covers. The unit must fail to a safe state if any fault is detected, and/or if interlock or guarding is removed. Guarding interlocks must be category 3 as described in AS4024

## 1.2 Safety Guidelines for Enclosed Installations (NHMRC/ARPANSA)

User responsibilities that must be adopted:

The user shall be responsible for the safe use of the X-ray equipment at all times and shall ensure that:

- all legislative requirements are satisfied;
- all safety features required are implemented and are regularly serviced and maintained in good working order; with records of servicing and maintenance displayed adjacent to the item;
- the requirements outlined in this safety manual are completed and maintained;
- no X-ray unit is operated while a safety feature is removed, modified, or inactivated;
- in the case of an actual or suspected exposure to the intense primary beam, the persons involved are referred for medical examination, medical reports are obtained, and full details of the incident are reported to the statutory authority as soon as possible (within 7 days of the incident by law);
- the signs required are prominently located and are maintained in a clean, intact, and legible state;

Each operator/user of an X-ray unit shall:

- at all times carry out established procedures of operation and maintenance.

## 1.3 Safety Guidelines for Partially Enclosed & Open Installations (NHMRC/ARPANSA)

For units that do not meet the requirements of enclosed apparatus, more stringent controls and requirements are to be implemented. Partly enclosed units which incorporate fixed shields and/or barriers shall be designed to give a clear and positive warning if the barriers or shields are incomplete. A clear and unambiguous notice shall also be displayed on or near the unit indicating the hazards of operating the unit while barriers or shields are incomplete.

Each partly enclosed unit shall satisfy the relevant requirements for enclosed units plus the following additional requirements:

- a. It shall be so constructed that it incorporates an enclosure or enclosures which partly enclose the primary X-ray beams sufficiently to ensure that no person may inadvertently expose any part of their body to a primary beam. The enclosure shall:
  - be interlocked or fixed so as to require the use of tools for removal;
  - incorporate collimator shields; and

- contain appropriate shielding material or be located at a sufficient distance from the X-ray tube that the dose of radiation at any accessible point five centimetres from the surface of each partial enclosure shall not exceed 25  $\mu$ Gy in one hour.
- b. It should be so sited that if for any reason a shutter is opened while an entrance to an enclosure is uncovered or barriers are incomplete, the resultant primary beam is directed away from areas that may be occupied. If such siting is not possible, beam stops or fixed shields shall be placed to adequately protect persons in these areas from the beam.
- c. It should be sited in a separate room or cubicle in which there are no other radiation sources.
- d. It should be constructed so that all operations are most easily and quickly carried out with all shields in place and all interlocks in operation.
- e. Should a fault occur, the item will fail to a safe mode.

#### 1.4 Non-Complying X-Ray Units

Each X-ray unit which does not comply with statutory requirements (i.e. does not meet the requirements for an enclosed or partly enclosed unit) shall not be used until modified to meet those requirements, unless the user has prior approval of the statutory authority to do so for an interim period. When such approval is given, a set of working rules approved by the statutory authority shall be drawn up for use pending the required modifications or replacement by a unit that complies. These working rules shall be designed to achieve the same standard of safety as the required modifications of the equipment, shall be prominently displayed on or near the X-ray unit, and shall be rigorously implemented. The interim working rules shall include rules and requirements as follows:

- a. The rules required for partly enclosed units shall be included, and implemented whenever the unit is used.
- b. Supplementary interim rules shall be included to minimise the risk that any person will be exposed to a primary X-ray beam from the unit or otherwise receive a dose of radiation in excess of the recommended dose limit. Additional protections including Time, Distance, Shielding and Containment to be adopted.
- c. A checklist of step-by-step procedures shall be prepared and used during the following operations:
  - before initiating an exposure;
  - during an exposure;
  - in terminating an exposure; and
  - during any non-routine operation of the unit, such as alignment of an X-ray beam.
- d. The unit shall not be operated if any person other than those essential to its operation occupies the cubicle, room, or area in which the unit is placed.
- e. No alteration should be made to the equipment in use with the unit unless the X-ray tube is de-energised.
- f. Interim working rules shall include the requirements for siting given in the previous parts, with the requirement 'should' being replaced by 'shall'.
- g. The requirements of the following part (radiation monitoring) shall be incorporated in the working rules with the following amendments:
  - The requirement 'should' in personal monitoring shall be replaced by 'shall'.
  - Periodical monitoring shall be performed not less than once in each month and the unit shall be thoroughly examined for hazards and all safety features checked at least once in each week. This requirement is the same as that for a partly enclosed unit.

- h. It is a legislated requirement that the appropriate warning and identification signs are used outside any area with radiation hazards. The trefoil symbol denotes some form of ionising radiation hazard.

### 3. Signage

Radiation warning signs and labels must conform to AS/NZS 1319 Safety signs for the occupational environment, and AS/NZS 2342 Development, testing, and implementation of information and safety symbols and symbolic signs. These indicate that colours for radiation warning signs and labels must be:

- Background: yellow
- Marking and trefoil: black

Appropriate signs shall be placed at the entryway to premises containing radiation hazards, including storage and waste facilities (which will also display an inventory). The area of the bench that is used for radioisotope work should be outlined with radiation warning tape (used to hold down the surface protector).

# CAUTION RADIATION





**Unauthorised use is prohibited.**

Hazardous radiation is emitted when the radioactive material is exposed from its shield.

Do not enter room without the correct protective equipment.

**PLEASE TELL US IF YOU  
SUSPECT YOU MIGHT BE  
PREGNANT.**

## Laboratory Signs

 <p>Charles Sturt University</p>		
<p><b>RADIATION AREA</b></p>		
Facility name:		
Location:		
Classification: <small>(as per the Radiation Control Regulation)</small>		
Occupier:		
Radiation Management Licence holder & number:	<p><b>Charles Sturt University 5061200</b></p>	
In an emergency, contact:		
Security:	<p><b>800 931 633 (external)</b></p>	
Facility manager:	<p>,</p>	
Alternate contact person:	<p>,</p>	

<b>Personal Protective Equipment (PPE)</b>	
<p><b>Required:</b></p> <div style="text-align: center;">   <b>Enclosed Shoes</b> </div> <div style="text-align: center;">   <b>Personal Monitoring Device (PMD)</b> </div>	<p><b>Upon instruction:</b></p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">   <b>Eye Protection (Safety Glasses)</b> </div> <div style="text-align: center;">   <b>Protective Clothing Lab Coat</b> </div> </div> <div style="text-align: center;">   <b>Gloves</b> </div>
<p><b>NO EATING, DRINKING OR COSMETIC APPLICATION</b></p> <p><b>AUTHORISED ENTRY ONLY</b></p>	

## 4. Shielding

CSU utilises radiation for various scientific, medical, diagnostic, and research purposes. This procedure describes the basic requirements for radiation shielding, facility design, and storage of radioactive material. Such shielding must be in accordance with Radiation Guideline 7 – Radiation Shielding Design Assessment and Verification Requirements.

This means that all areas where radiation is to be used need to be assessed to determine if shielding is required and to ensure that the shielding is adequate for the particular use. Shielding should be a central part of design from the earliest stages of facility and project planning.

Alpha particles may be completely stopped by a sheet of paper, beta particles by aluminium shielding. Gamma rays can only be reduced by much more substantial barriers such as lead, concrete or water.

This process also includes the need to reconsider the adequacy of shielding in existing radiation facilities when building modifications or increased building occupancy result in changes to previously unoccupied space adjacent to radiation facilities or sources.

The RSC will have suitable qualifications and experience in shielding design for the particular type of facility involved, or else an expert with qualifications and experience in shielding design for the particular type of facility involved must be consulted.

The RSC will assess the advice from consultants for accuracy and verify (via a professional consultant if necessary) that the shielding is implemented correctly during and after construction.

## 5. Storage and handling of regulated materials

### Procedures for the Safe Handling of Unsealed Sources of Radiation

- a. Unsealed source procedures are to be conducted in an appropriate and registered facility (see RMP Sections 9 and 15).

**Note:** A substance is only considered to be radioactive if its specific activity is at or exceeds 100 Bq/g and is deemed to require licensing if the total activity exceeds the thresholds listed in Schedule 1 of the Radiation Control Regulation. If a laboratory's occupants are using substances with activities below this threshold (e.g. < 400 kBq of I-125 in a radio-iodination lab), the lab still needs to be registered.
- b. When using unsealed radioactive sources, care should be taken to minimise internal and external contamination. Internal contamination may result from inhalation, ingestion, skin wounds or skin penetration. Note: No unsealed radioactive sources should be manipulated with unprotected hands. Gloves should always be worn.  $^{14}\text{C}$  on the skin may be absorbed into the body at a rate of 0.3% per minute (18% per hour).  $^3\text{H}$  (as tritiated water) may be absorbed through the skin at a rate of up to 23% per minute. Radionuclides of iodine, such as  $^{125}\text{I}$  and  $^{131}\text{I}$  can be volatile and should be handled in a fume cupboard.
- c. It should be remembered that penetration of gloves may occur when handling some iodine compounds. A second pair of gloves is thus recommended.
- d. To avoid contamination of hands, gloves should be removed in the proper surgical manner (remove one glove, hold in the other hand and fold the second glove over the first), and disposed of correctly after use.
- e. A laboratory coat or gown must be worn and must be buttoned up when handling radioactivity.
- f. Mouth pipetting of any substance, including radioactive substance is prohibited.
- g. Precautions should be taken to avoid punctures, cuts, and any open skin wounds.
- h. Cover all working surfaces with absorbent paper and clearly mark the area as a radiation working area. Plastic backed "underpad" is particularly suitable for this purpose.
- i. Wash hands thoroughly after using radionuclides.
- j. Pure beta emitters such as  $^{32}\text{P}$  and  $^{35}\text{S}$  should be handled whilst standing behind a protective barrier made of a low atomic number material such as Perspex.
- k. Radionuclides which emit gamma rays, such as  $^{131}\text{I}$ , will require appropriate thickness lead shielding.
- l. Food, beverages, smoking items, handbags, cosmetics, handkerchiefs, and eating and drinking utensils are prohibited in laboratories
- m. Food and drinks must never be stored in a refrigerator or freezer designated for radioactive materials.
- n. Contain waste appropriately and immediately.
- o. Be familiar with decontamination and radiation monitoring procedures.
- p. Use only self-adhesive labels in radiation working areas.
- q. Monitor radiation exposure by:
  - wearing a body personal radiation monitor and/or finger monitors if appropriate;
  - regular thyroid counting after performing iodinations; and
  - self-monitoring after working with unsealed sources.
- r. At the end of each procedure, the work area should be completely cleaned and checked for any contamination.





- s. All containers must be clearly labelled with the name of the radionuclide, its chemical form, and activity, along with the measurement time and date. If the material is sterile, this must be clearly indicated. The name of the responsible person should also appear on the label.
- t. All containers of radioactive material must be adequately shielded at all times.
- u. For activities of greater than 50 MBq, the container must never be directly handled. Remote handling devices, such as tongs, must be used instead.
- v. Non-radioactive work, particularly record keeping, must not be performed in the area designated for radioactive work.
- w. Glassware, forceps, scissors, and other instruments for use with radioactivity should be marked as such and not removed from the area.
- x. Maintenance work to fixtures and plant should be carried out only after the Radiation Safety Committee has given clearance.
- y. No new procedures involving radioactive substances are to commence until the Radiation Safety Committee has been consulted with regards to radiation safety.

## 6. Supervision within restricted areas

### The Radiation Safety Committee (RSC)

The RSC will ensure that the radiation laboratory, associated facilities, equipment, and training are compliant with current regulations, this Radiation Management Plan (RMP), and the approved project proposal.

The RSC will oversee and provide advice on radiation safety within laboratories using radioactive substances and/or ionising radiation apparatus, e.g. X-ray equipment. The RSC will be acting on behalf of the RML holder and will have the authority to make immediate adjustments to procedures, to immediately require a procedure to cease, or to shut down a facility.

### Principal Investigator

The Principal Investigator is responsible for ensuring that all research projects involving the use of radiation have been approved by the RSC, that all procedures are performed safely, and that all personnel working on the project are:

- appropriately trained (including specific training in radiation safety and emergency procedures);
- aware of the requirements of the RMP; and
- issued with and wear personal radiation monitors where necessary.

The Principal Investigator must ensure that all personnel working on the project are aware of, and comply with, these procedures.

### Subject Coordinator

The Subject Coordinator is responsible for ensuring that a teaching subject involving the use of radiation has been approved by the RSC, that all procedures are performed safely, and that all personnel working on the subject are:

- appropriately trained (including specific training in radiation safety and emergency procedures);
- aware of the requirements of the RMP; and
- issued with and wear personal radiation monitors where necessary.

The Subject Coordinator must ensure that all personnel working on the subject are aware of, and comply with, these procedures.

### Personnel Working on the Project

Must be supplied with the project approval and must perform all procedures in accordance with the RSC project approval and the RMP.

## 7. Personal protective equipment

- a. Protective clothing reserved specifically for radioactive work shall be worn at all times in the laboratory, even for very low levels of activity. The following shall apply:
  - i. for work in low level laboratories, a pink laboratory coat or overall is sufficient.
  - ii. for work in medium level laboratories, the pink laboratory coat shall have elasticized sleeve cuffs and a crossover front with high neck fastened with hook and loop fastening fabric. Pockets are not recommended.
  - iii. **Note:** Velcro strips have been found suitable.
- b. In high level laboratories, in addition to the pink laboratory coats or overalls, overshoes or similar specially designated footwear shall be worn to prevent the transfer of radioactive contamination from laboratory floors.
- c. Suitable gloves shall be worn for all work with unsealed radioactive substances, and special care is to be exercised when putting on or removing gloves, to avoid contaminating the hands and the inside surfaces of the gloves.
- d. Suitable eye protection must be worn at all times whilst in the Designated Radiation Area (the laboratory).
- e. Paper towels and tissues, which can be discarded as active waste after a single use, shall be used for personal purposes (such as hand drying, etc.) in the laboratory. Does it go into signed waste bin and is there any specific disposal requirements?
- f. All protective clothing worn in radioisotope and radiological laboratories shall be removed before leaving, and left in, or immediately outside, the laboratory; the latter place shall then be regarded as an 'active' area, i.e. possessing a potential contamination hazard. Contaminated protective clothing shall not be laundered with uncontaminated items.