Queensland

Regulatory Impact Statement for SL 1999 No. 330

Radiation Safety Act 1999

RADIATION SAFETY REGULATION 1999 AND RADIATION SAFETY STANDARDS

Title

Radiation Safety Regulation 1999.

Background

The *Radioactive Substances Act 1958* is to be repealed and replaced by the *Radiation Safety Act 1999*, which was passed by the Legislative Assembly on 27 April 1999.

The *Radiation Safety Act 1999* provides for the introduction of a modern system of radiation safety and protection. This Act was developed in light of an extensive review process, which was influenced by research and development work at state, national and international levels. The review took into account the recommendations of the peak national and international radiation advisory bodies in relation to the adverse health effects which may arise from exposure to different types of radiation and the measures that may be taken to prevent or minimise these effects.

The commencement of the *Radiation Safety Act 1999* is planned to coincide with the introduction of the *Radiation Safety Regulation 1999* and the making of radiation safety standards about certain sources of radiation and the premises at which these sources may be stored or used. The simultaneous commencement of this new legislative regime will enable the seamless introduction of a modernised system of radiation safety and protection for Queensland.

This Regulatory Impact Statement outlines the Government's proposals regarding the development of the *Radiation Safety Regulation 1999* and a number of radiation safety standards. The Queensland Government invites you to participate in the development of the regulation and standards, by commenting on any of the aspects presented in the Regulatory Impact Statement.

Authorising law

Section 215 of the *Radiation Safety Act 1999* provides the general head of power for the making of a regulation. More specific provisions regarding the matters to be covered by the *Radiation Safety Regulation 1999* are contained in sections 13, 18, 26, 28, 31, 36, 37, 38, 41, 42, 47, 51, 72, 74, 75, 79, 92, 96, 101, 127, 151, 207, 208, 209, 210, and Schedule 2 of the *Radiation Safety Act 1999*.

Section 16 of the *Radiation Safety Act 1999* empowers the Minister for Health to make radiation safety standards about radiation sources, premises where they may be used to carry out a radiation practice, and premises where radioactive substances may be stored. It should be noted that these standards will not be subordinate legislation. However, section 16 stipulates that the Minister must publish a gazette notice about the making of a radiation safety standard, and any such gazette notice shall be subordinate legislation. It is appropriate therefore, that the proposed standards be considered as part of this Regulatory Impact Statement.

Policy objectives

It is well recognised that exposure to ionising radiation and some forms of non-ionising radiation can adversely affect human health. Much of the knowledge about the adverse effects of ionising radiation exposure is based on long term epidemiological studies of the survivors of the atomic bombs at Hiroshima and Nagasaki. Further evidence as to the extent of these effects has subsequently been obtained through medical and scientific research undertaken at national and international levels by bodies such as the United Nations Committee on the Effects of Atomic Radiation (UNSCEAR), the International Atomic Energy Agency (IAEA) and the International Commission on Radiological Protection (ICRP). This knowledge, together with the expanded use of radiation in a wide range of industries, has

heightened awareness of the adverse health risks associated with radiation exposure.

In view of the potential health risks associated with radiation, since the late 1950s, the peak national and international radiation advisory bodies have developed and continually updated recommendations concerning the hazards associated with radiation. This ongoing study of radiation has enabled its continued use within acceptable safety limits, while increasing the understanding of the biological effects of radiation and capabilities for properly measuring radiation to minimise the health risks to any person.

The studies mentioned above have led to the development of nationally and internationally recognised guidelines about the ways in which radiation safety and protection should be enhanced. These guidelines advocate that:

- a system of radiation safety and protection should encompass sources of ionising radiation and harmful non-ionising radiation;
- the health risks associated with radiation must be restricted or minimised through the application of measures which have been developed in accordance with recognised philosophies of, and protocols for, radiation safety and protection;
- those persons authorised to possess, or engage in a practice involving the use of, a radiation source should bear the primary responsibility for the application of radiation safety and protection measures applicable to that source or practice;
- a safety culture should be developed among individuals and organisations dealing with sources of radiation in terms of the need for, and adherence to, radiation safety and protection measures; and
- governments have a broad range of responsibilities for radiation safety and protection such as the enactment of legislation to regulate the introduction and conduct of practices involving radiation, the provision of essential services for radiation safety and protection as well as being in a position to deal with emergencies that could result in members of the public being exposed to radiation.

The adverse health risks associated with exposure to radiation, and public expectations as to government’s public health responsibilities dictate that

some form of statutory regulation is necessary to enable government to prevent the use of radiation sources for purposes, or in circumstances, that would expose the public to an unacceptable risk of harm. There is a high degree of national and international consensus as to the need for regulatory controls over the use of radiation in order to promote and protect the public health.

The policy objective of Queensland's new radiation safety and protection legislation is to protect the people of Queensland from the adverse health risks associated with exposure to certain sources of ionising and harmful non-ionising radiation, while recognising the beneficial uses of radiation.

The *Radiation Safety Regulation 1999* and the Radiation Safety Standards have been developed in line with the objectives of the *Radiation Safety Act 1999*. They will aim to give effect to those aspects of the legislation that promote radiation safety in the community, while at the same time recognising the potential benefits of radiation.

The *Radiation Safety Regulation 1999* will establish matters in relation to:

- the sources of ionising and non-ionising radiation which are to be regulated under the legislation;
- the issuing of licences to possess or use radiation sources and to transport radioactive substances;
- the disposal of radioactive material and radiation apparatus;
- the period within which a possession licensee must obtain a certificate of compliance for radiation sources, and the premises where they will be stored or used;
- the measures and other matters that must be dealt with in a radiation safety and protection plan for a radiation practice for which a possession licensee is allowed to possess a radiation source under the licence;
- the appointment of certain radiation safety officers;
- specifying who may be authorised persons to prescribe therapeutic procedures or request diagnostic procedures involving the irradiation of persons;
- the maximum radiation dose limits for persons who may be

exposed to radiation as a result of their occupation, assisting with the carrying out of diagnostic or therapeutic procedure, being a volunteer in biomedical research or being exposed as a member of the public;

- exemptions from parts or all of the *Radiation Safety Act 1999*;
- the fees to be charged under the legislation; and
- the registers to be maintained by the chief executive of Queensland Health.

This regulation will replace the existing *Radioactive Substances Regulation 1961* and Part 14 of the *Health Regulation 1996*.

The making of radiation safety standards is integral to the introduction of a new process to ensure that radiation sources and premises where a radioactive substance is to be stored, or a radiation practice is carried out, meet specified safety standards. For example, under the *Radiation Safety Act 1999* a possession licensee must ensure that:

- a radiation source or a sealed source apparatus in their possession is not used unless it complies with the relevant radiation safety standard;
- a radiation source or sealed source apparatus in their possession is not used at premises, unless the premises comply with the relevant radiation safety standard; or
- radioactive substances in their possession are not stored at premises, unless the premises comply with the relevant radiation safety standard.

The minimum requirements specified in a radiation safety standard for a source or premises are technical in nature. As such, these requirements have been developed with reference to recognised standards, specifications and protocols published by peak national and international bodies.

How the policy objectives will be achieved

Queensland's new radiation safety and protection legislation continues to place strict controls on those activities that may result in the exposure of persons to radiation. For instance, the legislation will continue to control

whom, and under what circumstances, a person may possess, use, dispose of, or otherwise deal with certain sources of radiation.

Radiation Safety Regulation

Specific details about the provisions to be contained in the *Radiation Safety Regulation 1999* are covered in the Attachment 1 to this Regulatory Impact Statement. The major points are discussed below.

Possession Licensees

A possession licensee has major responsibilities and obligations under the *Radiation Safety Act 1999*, the primary ones being to ensure that:

- radiation sources and premises where a radioactive substance is to be stored or a radiation practice carried out comply with the relevant radiation safety standards (section 17);
- certificates of compliance have been obtained for radiation sources and the premises where radioactive substances are to be stored or where radiation practices are carried out (section 18);
- a copy of the licensee's approved radiation safety and protection plan for a radiation practice is available to, and is being complied with by those persons carrying out the practice (sections 33, 37 and 43);
- a radiation safety officer is appointed prior to a radiation practice being carried out (section 35);
- persons who may receive doses of radiation, in excess of the prescribed limits applicable to members of the public, are monitored to provide them with an on-going record of their exposure to radiation from the source used to carry out the practice (section 38);
- only those persons who are adequately trained or appropriately licensed are permitted to carry out radiation practices with radiation sources possessed by the licensee (sections 33 and 43);
- the health and safety of persons, in so far as exposure to radiation is concerned, are not adversely affected by the carrying out of a radiation practice with a source under their licence (section 43); and

- the chief executive is notified of certain dangerous events, so that the chief executive may assist the licensee to deal with the situation and to take the necessary action to prevent such an event re-occurring (section 45).

The *Radiation Safety Regulation 1999* will give effect to these responsibilities and obligations by:

- clarifying when a radioactive material is covered by the legislation, and therefore when a person must obtain a licence to possess a radiation source or radiation apparatus;
- setting out the requirements regarding the frequency of certification of radiation sources and radiation premises;
- addressing the radiation safety and protection measures to be dealt with in a possession licensee's radiation safety and protection plan;
- prescribing the radiation dose limits above which a possession licensee must put in place certain measures to ensure radiation safety and protection of all potentially exposed persons (eg. the provision of personal monitoring devices to individuals who carry out a radiation practice on behalf of the licensee); and
- spelling out how the possession licensee must meet their obligations about the disposal of radioactive material by prescribing the methods of disposal and the concentration limits for particular radionuclides that must not be exceeded in the radioactive material to be disposed of.

Use Licensees

The *Radiation Safety Act 1999* places a number of responsibilities upon use licensees. Principally, a use licensee must:

- comply with a code, protocol, standard or document about a radiation practice, that has been prescribed under a regulation, to which their licence relates (section 75);
- abide by the possession licensee's radiation safety and protection plan, when carrying out a radiation practice (section 34);
- not carry out a radiation practice unless they have access to the

approved radiation safety and protection plan for that practice (section 34);

- undergo the training program specified in the approved radiation safety and protection plan for the radiation practice (section 34); and
- take reasonable steps to ensure that the health and safety of persons, in so far as exposure to radiation is concerned, are not adversely affected by the way the use licensee carries out a radiation practice (section 44).

The *Radiation Safety Regulation 1999* will give effect to these responsibilities and obligations by providing further details about the circumstances under which a licence is, or is not, required.

The regulation will detail which use licensees will be required, as a standard condition of their licence, to comply with a particular code, protocol, standard or document about the radiation practice which they are authorised to carry out as a licensee. For example, a person who has been granted a licence to use an X-ray machine to perform diagnostic radiography must comply with the National Health and Medical Research Council's (NHMRC) "*Recommendations for minimising radiological hazards to patients*" (1985).

The radiation safety and protection measures that must be addressed in a possession licensee's radiation safety and protection plan for a radiation practice will be specified under the regulation. For example, the radiation safety and protection measures to be incorporated into a plan for a particular practice may require a use licensee to: use protective clothing and equipment; follow set procedures for the remote handling of certain radioactive substances; abide by the work practices and procedures designed to minimise radiation exposure; abide by the accident and emergency procedures governing the spillage of a radioactive substance; or participate in a personal radiation monitoring program.

In addition, a radiation safety and protection measure may specifically place an obligation on those use licensees who carry out a particular radiation practice. For example, where a person is to undergo diagnostic radiography for health related procedures, the plan may specify that the use licensee must ensure that the radiographic image produced is correctly marked with the patient's details (as prescribed as a radiation safety measure

under the regulation).

The regulation will also set out the circumstances under which a person may be exempt from the statutory requirement that only those persons who have been issued with a use licence may use a radiation source. For instance, a person undertaking borehole logging with a sealed radioactive substance will not be required to hold a use licence if they are using the radiation source in the presence of, and under the personal supervision of, a use licensee who is licensed to carry out this practice.

In the majority of instances, those persons who are currently exempt from having to hold a use licence will continue to be exempt. However, there will no longer be an exemption from licensing for persons using radiation sources for health related purposes whilst under the supervision and instruction of a use licensee.

Persons Carrying Out Radiation Practices

The concept of *carrying out a radiation practice* is a broader term which not only includes using the radiation from a source to achieve a desired outcome, but also performing other duties involving radiation sources, such as storing them (in the case of radioactive substances). While a person may be required to undergo training to ensure that these latter processes are undertaken in a safe manner, the person may not always be required to have expert knowledge and skills to carry out the practice. For example, a radiation source used on a production line may not depend upon operator skill for safe operation. Furthermore, the degree of risk associated with such a source may be minimal due to the presence of built-in or engineered safety features, which, for example, prevent direct access to the radiation from the radiation source.

As such, it may not always be necessary for a person carrying out a radiation practice to hold a use licence for that practice. The regulation will therefore set out those circumstances under which a person will be exempt from the statutory requirement that only those persons who have been issued with a use licence may use a radiation source to carry out a radiation practice. For example, a person using a cabinet radiation apparatus for baggage inspection at an airport would not be required to hold a use licence.

However, as with use licensees, under the *Radiation Safety Act 1999* a person carrying out a radiation practice is still obliged to:

- abide by the possession licensee's radiation safety and protection

plan, when carrying out a radiation practice (section 34);

- not carry out a radiation practice unless they have access to the approved radiation safety and protection plan for that practice (section 34);
- undergo the training program specified in the approved radiation safety and protection plan for the radiation practice (section 34); and
- take reasonable steps to ensure that the health and safety of persons, in so far as exposure to radiation is concerned, are not adversely affected by the way they carry out a radiation practice (section 44).

Transport Licensees

The *Radiation Safety Act 1999* states that a person must not transport a radioactive substance unless the person is licensed to transport the substance. The *Radiation Safety Regulation 1999* will define exactly what is meant by a radioactive substance and, as such will provide clarity as to when a transport licence is required.

The *transport of a radioactive substance* is not a 'radiation practice' for the purpose of the Act, as the regulatory requirements for transportation are quite different from those for radiation practices. For example, the necessity to adhere to a radiation safety and protection plan is not a requirement under the Act for the transport of radioactive substances. Instead, provision will be made through the regulation to ensure that persons transporting radioactive substances comply with international rules on the transport of such materials. The regulation will state that, as a standard condition of their licence, a transport licensee must abide by the Commonwealth "Code of Practice for the Safe Transport of Radioactive Substances 1990".

Persons Disposing of Radiation Sources

As with the existing legislation, it will be an offence for a person to dispose of radioactive material unless:

- the concentration or activity of a radionuclide in the material is not more than the maximum concentration or activity to be prescribed under the proposed regulation; or
- an approval to dispose of radioactive material has been granted under Part 7 of the Act.

The concentration or activity prescribed under the *Radiation Safety Regulation 1999* for the disposal of radioactive material will be set at a lower level than the prescribed concentration or activity for which a person must obtain a licence. Consequently, the provisions governing the disposal of radioactive material will apply not only to licensees but also to other persons, such as persons who carry out a radiation practice.

Unlike the existing legislation, the *Radiation Safety Act 1999* and proposed regulation will also regulate the disposal of radiation apparatus; containers that have been used for the transport or storage of radioactive material; and apparatus that once contained sealed radioactive substances.

Exemptions

It is acknowledged that under certain circumstances the use of radiation does not pose significant risks. Therefore, the *Radiation Safety Regulation 1999* will provide exemptions from the licensing requirements, for certain classes of persons. For example, particular classes of persons undergoing training in the use of radiation sources will not be required to obtain a use licence, where they are working in the presence and under the personal supervision of a use licensee. Such exemptions will cover undergraduate students enrolled in a recognised radiography course, or assistants to industrial radiographers.

The regulation will also exempt some radiation sources from some or all of the requirements of the *Radiation Safety Act 1999*. For instance, certain types of smoke detectors will be exempt from all or some of the requirements of the Act.

Radiation Safety Standards

Specific details about the provisions to be contained in the radiation safety standards are covered in the Attachment 2 to this Regulatory Impact Statement. The major points are discussed below.

The *Radiation Safety Act 1999* introduces a new process to ensure that radiation sources, including the premises at which they are to be stored or used, meet specified safety standards. Section 16 of the Act empowers the Minister for Health to make radiation safety standards about:

- radiation sources (ie. radiation apparatus or radioactive substances) in relation to the carrying out of radiation practices;

- the sealing of radioactive substances;
- sealed source apparatus;
- premises at which radiation sources are used to carry out radiation practices; or
- premises at which radioactive substances are stored.

Radiation safety standards will be technical in nature, and will set out the minimum requirements that will ensure radiation safety and protection in the operation of a radiation source, or the premises at which a radiation practice is carried out. For example, a standard about a radiation source used to carry out a radiation practice will set out the criteria against which a source is to be assessed in order to determine that it is not only safe to operate, but reliable and accurate. More specifically, the minimum requirements for a source will specify matters in relation to radiation output, radiation leakage, operating controls and indicators, automatic exposure and tomographic functions, collimators, etc. A standard about premises at which the source is to be used to carry out a radiation practice will specify the minimum requirements for radiation shielding and engineered controls (such as interlocks and illuminated warning signs) in the premises where the source is to be used.

The radiation safety standards (which are detailed in Attachment 2) have been developed with reference to recognised standards, specifications and protocols published by bodies such as the Standards Association of Australia, the National Health and Medical Research Council, the National Occupational Health and Safety Committee, the International Atomic Energy Agency, the American Association of Physicists in Medicine and the Royal Australasian College of Radiology.

CONSISTENCY WITH AUTHORISING LAW AND OTHER LEGISLATION

The *Radiation Safety Regulation 1999* and Radiation Safety Standards are consistent with the authorising law, as they have been developed in line with the objectives of the *Radiation Safety Act 1999.* They will aim to give effect to those aspects of the legislation that are intended to promote radiation safety in the community, while at the same time recognising the potential benefits of radiation.

It is not appropriate for the *Radiation Safety Act 1999*, the *Radiation Safety Regulation 1999* and the Radiation Safety Standards to address all safety and protection concerns regarding activities that involve the use of radiation. For example, the objectives of the Act do not cover the extraction of radioactive ore on a mining lease, nor is it proposed that the legislation regulate all forms of non-ionising radiation. Accordingly, the *Radiation Safety Act 1999* and associated subordinate legislation will work alongside other legislation such as the *Coal Mining Act 1925*, the *Environmental Protection Act 1994*, the *Mineral Resources Act 1989*, the *Mines Regulation Act 1964*, and the *Workplace Health and Safety Act 1995*.

OPTIONS AND ALTERNATIVES

The policy objectives of the *Radiation Safety Act 1999* cannot be fulfilled without the making of supporting subordinate legislation. For this reason it is not appropriate to consider any alternative to making the *Radiation Safety Regulation.* The proposed regulation will assist in achieving the objectives of the Act by, for instance:

- providing for the regulation of harmful sources of non-ionising radiation (ie. Class IV lasers used for therapeutic and cosmetic purposes);
- introducing radiation safety and protection measures which reflect contemporary radiation safety and protection principles, and more accurately and clearly reflect the responsibilities which should be borne by licensees and those persons who carry out radiation practices (eg. obligations in relation to radiation safety and protection plans);
- providing, through the frequency of the proposed certification process, a more effective means of ensuring that radiation sources, and premises at which those sources are stored or used, meet applicable radiation safety standards; and
- ensuring that broader environmental considerations are taken into account when decisions are made about the disposal of radiation sources, by prescribing activity concentration limits for radioactive material or radiation apparatus to be disposed of.

COST-BENEFIT ANALYSIS

Cost-benefit analyses have been undertaken for community, government and industry groups likely to be affected by the proposed regulation and radiation safety standards. These analyses are set out below.

Community

Benefits

The proposed legislative regime will provide the community with increased consumer protection and consumer confidence about the use of radiation. For instance, the regulation will give effect to those provisions of the *Radiation Safety Act 1999* which:

- Require a possession licensee to develop and implement a radiation safety and protection plan for the radiation practice which is to be carried out with the radiation sources the licensee is allowed to possess under his or her licence. In addition to the matters specified under section 28 of the Act, the plan must address those radiation safety and protection measures prescribed under the regulation, which are to be implemented to prevent or minimise health risks to any person as a result of a radiation practice being carried out.
- Specify that only an authorised person may prescribe a therapeutic procedure or request a diagnostic procedure involving the irradiation of a person. An authorised person will be prescribed in the *Radiation Safety Regulation 1999* as a person with the appropriate experience, skills and training relevant to the procedure to be carried out. For example, for computed tomography an authorised person will be someone registered as a specialist in the field of diagnostic radiology under the *Medical Act 1939*.
- Impose stringent controls over the transport of radioactive substances. The regulation will give effect to the requirement that all transport licensees will be obliged to comply with the Commonwealth "Code of Practice for the Safe Transport of Radioactive Substances 1990" as a standard condition of their licence.

Costs

While the requirements of the proposed regulation and standards may result in some additional costs for certain businesses, it is not envisaged that these costs will be passed on to consumers.

Government

Benefits

The *Radiation Safety Act 1999* and its associated subordinate legislation will allow the government to respond positively to public expectations about the government's role in preventing the use of radiation in ways that would expose the public to an unnecessary risk of harm.

The government will be undertaking a monitoring and compliance program that will involve the auditing of businesses which, or individuals or service providers who, are licensed under the Act. The auditing process will ensure compliance not only with the Act but the *Radiation Safety Regulation 1999* and radiation safety standards. The conduct of audits will also provide inspectors with a valuable opportunity to offer licensees information about improvements which may be made to their business to better achieve radiation safety, particularly where such improvements can be achieved at no cost.

Costs

The government will aim for a cost neutral approach to the introduction of the new legislation. That is, where possible additional costs in implementing a comprehensive monitoring program of radiation safety will be offset by savings in areas such as administration.

Industry

The impact of the new legislation upon industry will be varied due to the range of participants and the diversity and size of their respective businesses. Therefore, the cost—benefit analysis for industry has been undertaken in relation to the three principal groups to be affected (ie. possession licensees, use licensees, and transport licensees), as well as new entry participants (radiation safety officers and accredited persons).

Benefits

Possession Licensees

Possession licensees will benefit from the transparency of the new legislation, as it more clearly sets out their various obligations in relation to radiation safety and protection, for example:

- Radiation safety standards set out the minimum requirements for the safe operation of radiation sources and the storage of radioactive substances. Whereas, the regulation sets out the frequency with which a possession licensee will be required to have a source or premises certified to ensure continuing compliance with the requirements of the relevant radiation safety standard.
- The regulation sets out the radiation safety and protection measures that must be incorporated in a possession licensee's radiation safety and protection plan. These measures provide for the responsibilities of a possession licensee as opposed to the person carrying out a radiation practice to be detailed in the plan.
- The regulation, in conjunction with the Act, sets out the functions to be undertaken by the radiation safety officer appointed by a possession licensee for a radiation practice.

Use Licensees

Use licensees will also benefit from the transparency provided by the new legislation, which clearly sets out and delineates between their obligations and those of possession licensees. For example, the regulation will set out the radiation safety and protection measures that should be addressed in a possession licensee's radiation safety and protection plan. These measures ensure the safety of use licensees and others involved in the carrying out of a radiation practice.

The cost of renewing a use licence will decrease under the new legislation. That is, the application fee for the renewal of a use licence will be reduced from $41.00 to $35.00 per annum and the term of a use licence will be increased from one to a maximum of three years. As with other licensees, an existing use licensee will have a minimum of 3 months and a maximum of 12 months to apply for a licence under the new Act, depending on when their current licence expires.

Industry participants will also benefit by the exemption provisions proposed under the *Radiation Safety Regulation 1999.* These provisions will add clarity about who is required to obtain a use licence, as well as at what stage a use licence becomes mandatory (eg. for those persons undergoing training which involves the irradiation of another individual for a health related purpose). Furthermore, the regulation will make provision for certain use licensees to be exempt from the requirement to obtain a transport licence, where transport of a radioactive substance is integral to their business. Examples of these exemptions are an industrial radiographer involved in testing of gas pipelines for fractures; or a soil density and moisture gauge operator who moves from project to project testing the compaction of asphalt on new road projects.

Transport Licensees

The *Radiation Safety Regulation 1999* will continue to require transport licensees to abide by the Commonwealth "Code of Practice for the Safe Transport of Radioactive Substances 1990". This Code sets out internationally accepted standards for the packaging, loading and transport of radioactive substances. As such, compliance with the Code not only ensures the safety of those persons transporting radioactive substances but also minimises the hazards associated with the transport of these substances that could result in other persons, their property or the environment being endangered.

Existing transport licensees will also benefit, as the cost of renewing a transport licence will decrease under the new legislation. That is, the application fee for the renewal of a transport licence will be reduced from $41.00 to $35.00 per annum and the term of a transport licence will be increased from one to a maximum of three years.

Radiation Safety Officers

Under the new *Radiation Safety Act 1999*, a possession licensee is required to have a radiation safety officer appointed whenever a radiation practice is being carried out. A person may only offer their services as a radiation safety officer if they hold a radiation safety officer certificate relevant to the practice being carried out. However, it is recognised that certain sole practitioners in private practice (e.g. chiropractors, dentists, and veterinary surgeons), who are already required to obtain both a possession and use licence, would have the necessary knowledge and skills to fulfill the functions of a radiation safety officer. As such, the Act makes provision for

certain practitioners to appoint themselves as the radiation safety officer for their practice, provided they hold a qualification, relevant to the practice, prescribed under a regulation.

Those possession licensees who hold these qualifications can meet their obligations under the Act without having to obtain a radiation safety officer certificate, or engage another person who holds a radiation safety officer certificate, relevant to the radiation practice to be carried out.

Accredited Persons

The legislative requirement that radiation sources, premises where radiation sources are used and premises where radioactive substances are stored meet specified radiation safety standards will create new business opportunities. As detailed in Attachment 2, at this stage, it is proposed that a number of radiation safety standards be made, which will cover a diverse range of sources and premises.

Under the Act only those persons who hold an accreditation certificate for a particular type of radiation source or premises will be able to issue a certificate of compliance for that source or premises. Accredited persons will require specialist qualifications, skills and knowledge in order to fulfil the requirements of their role, given the nature of the radiation sources they will handle and the diverse range of radiation practices carried out by industry. As such, those accreditation bodies, institutions or businesses that can offer such training will also benefit from the introduction of the new legislative regime.

Summary

Generally, industry participants will benefit due to:

- increased consumer confidence through the introduction of a more modern system of radiation safety and protection;
- the legislation being designed to better reflect current business practices;
- the clear delineation of the responsibilities to be borne by industry participants to ensure that radiation safety and protection is maintained at all times;
- the potential for expanded business opportunities;

- a reduction in the number of licences a person or corporation must hold to participate within the market;
- clarity regarding what licences are required to operate within the market;
- decreased application fees for the renewal of certain licences (ie use and transport);
- the term of most licences being increased from one to a maximum of three years; and
- the legislation setting out with greater clarity the entry requirements for industry participants.

Costs

Possession Licensees

Unlike the existing legislation, it is intended that Queensland's new radiation safety and protection legislation will not only regulate sources of ionising radiation but certain sources of harmful non-ionising radiation. It is therefore proposed that the *Radiation Safety Regulation 1999* will specify that a Class IV laser used to carry out diagnostic, therapeutic or cosmetic procedures is a radiation apparatus for the purposes of the legislation. As such, those persons who are currently in, or who intend to take, possession of such an apparatus will be required to obtain a possession licence under the *Radiation Safety Act 1999*. These persons will then be required to comply with the obligations and responsibilities of a possession licensee under the legislation.

Under the *Radiation Safety Act 1999*, a possession licensee is required to obtain a certificate of compliance for a radiation source, or the premises where radioactive substances are to be stored or a radiation practice carried out, if a relevant radiation safety standard exists for the source or premises. The certificate can only be issued if the source or premises meet the relevant radiation safety standard. The possession licensee must pay for the services of an accredited person (who is suitably qualified for that role), to assess whether the source or premises do in fact meet the radiation safety standard.

Many possession licensees already seek such certification as part of the routine servicing of their equipment. However, the impact of this new statutory requirement on licensees will vary, depending upon the nature and size of their businesses. For instance, a large corporation with a number of

radiation sources to be certified will experience a greater increase in costs than an individual possession licensee operating a small business.

The new Act also requires possession licensees to develop a radiation safety and protection plan for their radiation practice. This plan must, among other matters, address the radiation safety and protection measures prescribed under the *Radiation Safety Regulation 1999* for a particular radiation practice. Some possession licensees may experience increased costs due to this requirement. However, these costs will be minimal, as existing licensees are required to prepare documents, which set out the working rules and emergency procedures for their particular radiation practice as a condition of their licence. Costs involved in developing a radiation safety and protection plan will also be minimal for those persons who currently possess and operate Class IV lasers in accordance with Australian Standard AS/NZS.4173:1994 *Guide to the safe use of lasers in health care*.

The *Radiation Safety Regulation 1999* sets out a new fee structure for possession licences, including the renewal of possession licences. These fees have been increased in line with the objective of achieving cost neutrality for the administration of the new radiation safety and protection regime. Considerable costs are incurred in assessing applications for possession licences, as well as in the ongoing auditing of radiation sources held by possession licensees and the use of these sources to carry out radiation practices.

Fees charged under the existing *Radioactive Substances Regulation 1961* have not been reviewed for many years. Furthermore, there are considerable inequities in the market under the existing system of licensing. That is, persons with an array of radiation apparatus or radioactive substances currently incur the same licence fee as those persons with few radiation sources. For example, a dentist possessing one X-ray machine must pay the same fee as a large private diagnostic radiology service possessing many radiation apparatus.

It is envisaged that the new fee structure will permit greater cost recovery, while at the same time instituting a more equitable system of charging under the legislation. The impact of the proposed fee structure on existing possession licensees will vary depending upon the size of a possession licensee’s business.

The *Radiation Safety Act 1999* provides a transitional period of 6 months within which an existing possession licensee must comply with the requirements of the new legislation. In practice, however, an existing possession licensee will have a minimum of 9 months and a maximum of 18 months to comply with these requirements, depending on when their current licence expires. Those individuals who will be required to obtain a possession licence for a Class IV laser for diagnostic, therapeutic or cosmetic purposes will be given 6 months from the commencement of the legislation, to apply for a licence and meet the requirements of the new Act.

Use Licensees

Existing use licensees will not face any additional costs under the *Radiation Safety Regulation 1999*. In fact, as detailed previously, the cost of renewing a use licence will decrease.

However, those persons applying for a use licence for the first time, or for a different type of use licence, will be subject to the new fee structure that is to be introduced under the regulation. The fee for an initial application has been increased to cover the costs of assessing such applications. These costs were not recouped in the past, but these expenses can no longer be borne if the government is to achieve cost-neutrality in the implementation of the new legislative regime.

The new fee structure for an initial application is likely to impact on those individuals who will no longer be exempt from the use licensing requirements of the legislation. For example, those individuals working in the health care and personal appearance industries who use radiation. However, it is not envisaged that this proposal will have a significant impact on persons within the health care industry who are currently using ionising radiation. The majority of these persons have already elected to obtain a use licence under the existing legislation in anticipation of the new legislation being introduced.

It would also appear that the majority of persons in the health care and personal appearance industries have sufficient training and expertise to meet the criteria for a use licence under the *Radiation Safety Act 1999*. Therefore, any additional costs under the new legislation will be limited to the application for a use licence.

Transport Licensees

Existing transport licensees will not face any additional costs under the *Radiation Safety Regulation 1999*. In fact, a certain proportion of these licensees will not be required to renew their licences under the new legislation. As detailed above, it is intended that the regulation will make provision for certain use licensees to be exempt from the requirement to obtain a transport licence, where transport of a radioactive substance is integral to their business

However, those persons applying for a transport licence for the first time, or for a different type of transport licence, will be subject to the new fee structure that is to be introduced under the regulation. As with use licences, the fee for an initial application has been increased to cover the costs of assessing such applications.

New transport licensees will also be required to meet any costs that may arise from the proposed legislative requirement that radioactive substances be transported in compliance with the Commonwealth "Code of Practice for the Safe Transport of Radioactive Substances 1990". For example, under this code of practice, a person may incur costs relating to the packaging of an item to be transported; placarding of vehicles to be used for this type of transport; or training of persons involved in the transport of radioactive substances. These types of costs exist under the current legislation and will be identical under the new legislation.

FUNDAMENTAL LEGISLATIVE PRINCIPLES

The proposed regulation and radiation safety standards have sufficient regard to the rights and liberties of individuals and the institution of Parliament.

ATTACHMENT 1

RADIATION SAFETY REGULATION

LEGISLATIVE PROPOSAL

Queensland Department of Health

July 1999

CONTENTS

KEY TERMS

The primary focus of the *Radiation Safety Act 1999* is on the regulation of *radiation sources.*

A radiation source is defined as being either a *radioactive substance* or a *radiation apparatus.*

A *radioactive substance* is any radioactive material that is prescribed to be a "radioactive substance" based on the concentration or activity of a radionuclide in the material.

Examples of radioactive substances that are to be covered by the legislation include:

- substances incorporated in industrial gauges which are used in the manufacturing of soft drinks to measure the level of liquid in a can or used in the manufacturing of textiles to measure the thickness of fabrics;
- substances used in the coal industry to assist with process control or quality assurance functions; or
- substances used in radiation oncology for the treatment of cancer.

A *radiation apparatus* is an apparatus that emits an amount of ionising or non-ionising radiation during a particular period higher than the minimum amount prescribed, for the period, under a regulation.

Examples of radiation apparatus that are to be covered by the legislation include:

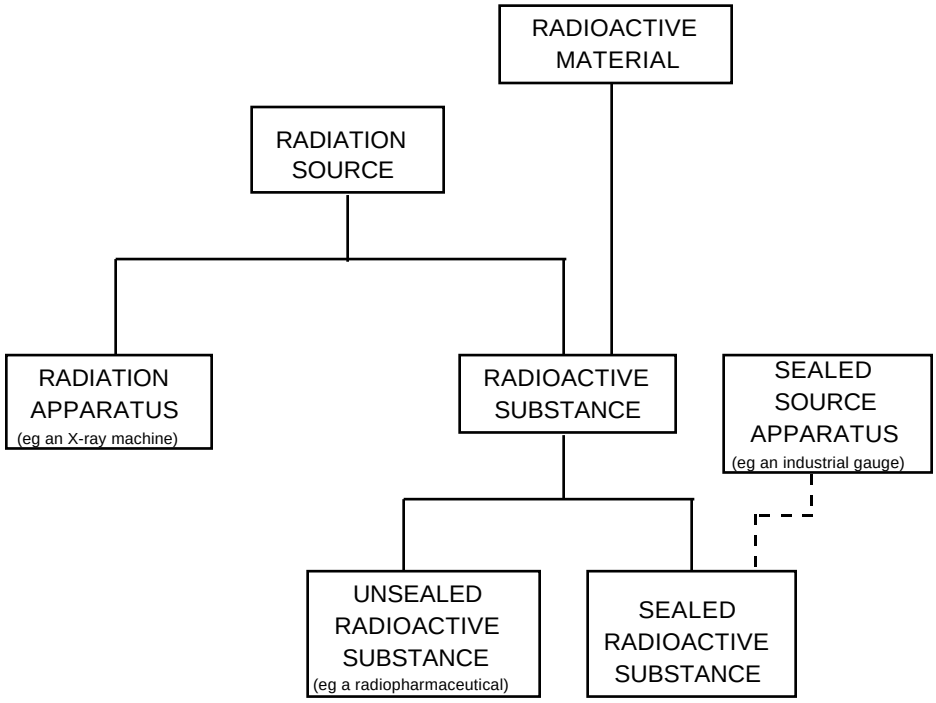
- X-ray machines used in diagnostic radiography;
- class IV lasers used in surgery; and
- baggage inspection devices used at airports.

Other key terms used in the legislation are:

- *sealed radioactive substance*, which is a radioactive substance that is sealed to minimise the escape or dispersion of the substance.
- *unsealed radioactive substance*, which is, for example, a radiopharmaceutical that is injected into a person to assist in the diagnosis of certain diseases such as cancer of the bone; or with treatment of malignant or benign conditions.

- *sealed source apparatus*, which is an apparatus that incorporates a sealed radioactive substance. For example, Americium241 incorporated in an industrial gauge which is used to detect the level of liquid in soft drink cans; or Caesium137 in a borehole logging tool used in mining explorations to ascertain the nature of the strata many hundreds of metres below the earth's surface.
- *radioactive material*, which is material that spontaneously emits ionising radiation as a result of the radioactive decay of a radionuclide in it. However, *radioactive material* does not include a mineral within the meaning of the *Mineral Resources Act 1989* situated within the boundaries of land the subject of a mining lease, mineral development licence or exploration permit within the meaning of that Act.

The above terms are presented diagrammatically below.



PRESCRIPTION OF RADIATION SOURCES

RADIOACTIVE SUBSTANCES

For the purposes of the legislation, the term radioactive substance is defined as meaning radioactive material (whether or not it is sealed):

(a) containing more than the concentration or activity of a radionuclide prescribed under a regulation; or

(b) prescribed under a regulation to be a radioactive substance.

At this time, it is only intended that part (a) of this definition be utilised to determine whether a particular radioactive material constitutes a radioactive substance. Part (b) of the definition may be used in the future to capture radioactive materials which should be subject to the radiation safety and protection requirements of the legislation due to peculiar circumstances of their use or effect upon the environment, but which are not captured by part (a) of the definition.

Schedule 1 of this Paper lists the activity concentrations and activities of the radionuclides to be prescribed under the proposed regulation. This Schedule, which is comprised of two parts, has been developed with regard to Safety Series No.115, *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources*, International Atomic Energy Agency, Vienna, 1996. Part 1 sets out the minimum activity concentration and minimum activity of various radionuclides. Where the radionuclides listed in Part 1 have other radioactive decay products (progeny) associated with them, these are listed in Part 2.

Where radioactive material contains a radionuclide listed in Column 1 of Part 1 of Schedule 1, that material is a radioactive substance for the purposes of the legislation if:

(a) the **activity concentration of the radionuclide** [1] in the material equals or exceeds the activity concentration for the radionuclide listed in Column 2 of Part 1 of Schedule 1; and

(b) the **activity of the radionuclide** in the material equals or exceeds the activity for the radionuclide listed in Column 3 of Part 1 of Schedule 1.

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[1] Where a term is printed in **bold** font, a definition can be found immediately below and/or in the Glossary at Appendix 1.

The activity concentration of a radionuclide is defined as meaning the concentration of the radionuclide measured in **becquerels** (Bq) per stated mass in grams of the radioactive material.

The activity of a radionuclide is defined as meaning a measure of the rate of spontaneous nuclear transformation of the radionuclide.[2]

RADIATION APPARATUS

For the purposes of the legislation, the term radiation apparatus is defined as meaning:

(a) an apparatus that, when energised, emits an amount of ionising radiation during a particular period higher than the amount prescribed, for the period, under a regulation; or

(b) an apparatus that would if assembled or repaired, and when energised, be capable of emitting an amount of ionising radiation during a particular period higher than the amount prescribed, for the period, under a regulation; or

(c) an apparatus, prescribed under a regulation, that when energised emits an amount of non-ionising radiation during a particular period higher than the amount prescribed, for the period, under a regulation; or

(d) an apparatus, prescribed under a regulation, that would if assembled or repaired, and when energised, be capable of emitting an amount of non-ionising radiation during a particular period higher than the amount prescribed, for the period, under a regulation.

Ionising radiation apparatus

It is proposed that an apparatus is an ionising radiation apparatus if, when energised, it emits an amount of ionising radiation greater than 1 **microgray** per hour at 10 centimetres from any accessible surface of the apparatus.

An apparatus is also an ionising radiation apparatus if it would, when assembled or repaired, and when energised, be capable of emitting an

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2 The Macquarie Dictionary, 3rd edition (1997)

amount of ionising radiation greater than 1 microgray per hour at 10 centimetres from any accessible surface of the apparatus.

Non-Ionising Radiation Apparatus

At this time, it is only proposed that one type of non-ionising radiation apparatus will be regulated under the *Radiation Safety Act 1999*. That is, Class IV lasers which are used, or intended to be used, to perform health related or cosmetic procedures, for example:

- Nd-YAG lasers used by gynaecologists to treat lesions, endometrial ablation or laparoscopic procedures;
- Carbon dioxide lasers used by dermatologists or plastic surgeons for skin resurfacing;
- Laser diodes that are used for a range of surgical applications including urology, the treatment of conditions associated with ear, nose and throat and ophthalmology.

It is proposed that an apparatus is a non-ionising radiation apparatus if:

(a) when energised, it is capable of emitting non-ionising radiation at any accessible point on the apparatus, to a level greater than the amount specified in Table 4 of the Australian/New Zealand Standard AS/NZS 2211.1:1997 *Laser Safety: Part 1: Equipment classification, requirements and user's guide*, published by Standards Australia: Homebush, NSW; and

(b) it is used, or is intended to be used, for a diagnostic, therapeutic or cosmetic procedure involving the irradiation of a person.

An apparatus is also a non-ionising radiation apparatus if:

(a) it would, when assembled or repaired, and when energised, be capable of emitting non-ionising radiation at any accessible point on the apparatus, to a level greater than the amount specified in Table 4 of the Australian/New Zealand Standard AS/NZS 2211.1:1997 *Laser Safety: Part 1: Equipment classification, requirements and user's guide*; and

(b) it is used, or is intended to be used, for a diagnostic, therapeutic or cosmetic procedure involving the irradiation of a person.

LICENCES

The *Radiation Safety Act 1999* provides for the issuing of three types of licences, namely—*possession licence*, *use licence* and *transport licence*.

A possession licence is required when a person wishes to possess a radiation source. The licence will authorise the person to possess a radiation source for the purpose of carrying out a particular radiation practice.

However, it is not intended to require a person to hold a possession licence if they wish to possess ores or rock samples in their natural state (which, naturally, contain minerals incorporating radionuclides), for the purpose of teaching in facilities (such as schools, colleges or universities); or for demonstration purposes in a museum or other display; provided that the radiation emitted from the ore or rock sample is less than or equal to 1 microgray per hour at 10 centimetres from the ore or rock sample.

A use licence is required when a person wishes to use a radiation source. "Use" means actual use of the radiation emitted from a source. This licence will authorise a person to use a radiation source for the purpose of carrying out a particular radiation practice.

A transport licence is required for the transport of a radioactive substance. If transport is to be undertaken by road, a transport licence may be issued only to the individual in charge of the vehicle transporting the substance. Where transport will be otherwise than by road (eg. rail, air or sea) the person required to hold a transport licence is the person transporting the source and responsible for its safety during transit. In this latter instance, a person can also include a corporation.

It should be noted however, that the *Radiation Safety Act 1999* provides for exemptions to be made from the licensing requirements. Details about the nature of these exemptions can be found in the section on "Exemptions" in this Legislative Proposal. Specific exemptions from the licensing requirements are also provided under sections 12(3) and 14(3) of the Act.

STANDARD CONDITIONS ATTACHED TO A LICENCE

Section 75 of the *Radiation Safety Act 1999* makes provision for standard conditions to be attached to a licence granted under the legislation, that is:

(a) As a condition of their licence, a possession or use licensee will be required to comply with a code, protocol, standard or

document about the radiation practice to which their licence relates, where such codes, protocols, standards, etc are prescribed under a regulation.

(b) As a condition of their licence, a transport licensee will be required to comply with a code, protocol, standard or document about the transport of radioactive substances, where such codes, protocols, standards, etc are prescribed under a regulation.

It is intended that a regulation be made so that a use licence granted in relation to the radiation practices listed below will be subject to the condition that the holder of the licence comply with the code, protocol, standard or document listed for that practice.

Use Licence Type	**Standard Condition—Code, protocol, standard or document**
Use of a radiation apparatus or radioactive substance for diagnostic procedures.	National Health and Medical Research Council's *Recommendations for minimising radiological hazards to patients* (1985).
Use of a radioactive substance for therapeutic procedures.	National Health and Medical Research Council's *Recommendations relating to the discharge of patients undergoing treatment with radioactive substances* (1983).
Use of a radiation apparatus or radioactive substance for research involving human subjects.	National Health and Medical Research Council's *Administration of ionizing radiation to human subjects in medical research* (1984).

The regulation will also provide that all transport licences granted under the *Radiation Safety Act 1999* will be subject to the condition that the holder of the licence complies with the Commonwealth of Australia's *Code of*

Practice for the Safe Transport of Radioactive Substances 1990, issued under the provisions of the *Environment Protection (Nuclear Codes) Act 1978* (Cwlth) and published by the Australian Government Publishing Service, Canberra.

CERTIFICATES OF COMPLIANCE

The *Radiation Safety Act 1999* provides for the introduction of a new process to ensure that radiation sources, including the premises at which they are to be stored or used, meet nationally agreed upon safety standards. To this end, the Act empowers the Minister for Health to make radiation safety standards.

Section 18 of the Act specifies that where a possession licensee intends to use a radiation source or a sealed source apparatus, the licensee is required to obtain a certificate of compliance for the following, where there is a relevant radiation safety standard:

- a radiation source (which includes radiation apparatus, sealed radioactive substances and unsealed radioactive substances);
- the sealing of a radioactive substance;
- a sealed source apparatus.

The possession licensee must obtain the necessary certificate of compliance within a prescribed period. That is, a certificate of compliance must be issued for the source or apparatus within the prescribed period of time before the possession licensee allows the source or apparatus to be used to carry out the radiation practice for which the licence is held. Once that prescribed period of time has passed, a fresh certificate of compliance must be obtained before the radiation source or apparatus can continue to be used.

In addition, the legislation specifies that a possession licensee may be required to obtain a certificate of compliance for premises if there is a relevant radiation safety standard for the premises. Radiation safety standards may be made about:

- premises at which radiation sources are used to carry out radiation practices; and
- premises at which radioactive substances are stored.

Again, the possession licensee must obtain the necessary certificate of compliance within a prescribed period. That is, a certificate of compliance must be obtained prior to the possession licensee allowing:

- a radiation practice to be carried out at premises; or
- a radioactive substance to be stored at premises.

In summary, as part of the radiation safety and protection framework provided for under the *Radiation Safety Act 1999*, possession licensees must ensure that:

(a) a radiation source or a sealed source apparatus in their possession is not used unless a certificate of compliance has been obtained for the source or apparatus within the prescribed time period;

(b) a radiation source or sealed source apparatus in their possession is not used at premises, unless a certificate of compliance has been obtained for the premises within the prescribed time period;

(c) radioactive substances in their possession are not stored at premises, unless a certificate of compliance has been obtained for the premises within the prescribed time period.

Attachment 2 sets out in more detail further information about the radiation safety standards that are relevant to:

- a radiation source or a sealed source apparatus;
- a premises at which the source is to be used to carry out a radiation practice; or
- a premises at which a radioactive substance is to be stored.

It is proposed that the prescribed periods within which a certificate of compliance must be obtained shall be those which are set out below:

- For ionising radiation apparatus or radioactive substances (whether sealed or unsealed) used for irradiating another person for diagnostic (other than intra-oral dental diagnostic radiography), therapeutic or research purposes the prescribed period for obtaining a certificate of compliance is to be **1 year**.
- For ionising radiation apparatus used to carry out intra-oral dental diagnostic radiography the prescribed period for obtaining a certificate of compliance is to be **2 years**.
- For all other ionising radiation apparatus or radioactive substances used to carry out a radiation practice, the prescribed period for obtaining a certificate of compliance is to be **3 years**.
- For non-ionising radiation apparatus (ie. Class IV lasers for health related or cosmetic procedures) the prescribed period for obtaining a certificate of compliance is to be **1 year**.

- For premises where radioactive substances are stored or used to carry out a radiation practice and premises where radiation apparatus (whether ionising or non-ionising) are used to carry out a radiation practice, the prescribed period for obtaining a certificate of compliance is to be **5 years.**

DISPOSAL OF RADIATION SOURCES

DISPOSAL OF RADIOACTIVE MATERIALS

Section 26 of the *Radiation Safety Act 1999* states that a person must not dispose of radioactive material, unless—

(a) the concentration or activity of a radionuclide in the material is not more than the maximum concentration or activity prescribed under a regulation; or

(b) the person is the holder of an approval to dispose of the material and disposes of it as required under the approval.

In addition, the legislation states that a regulation may specify the point of disposal at which the concentration or activity of the radionuclide in the material is to be decided.

Uncontrolled disposal of radioactive material has the potential to cause risk to the public health and to the environment. Therefore, it is proposed that a regulation be made setting out the activity concentration limits for disposal of radioactive material, which will ensure that the public and the environment are adequately protected.

These limits are to be prescribed for the disposal of radioactive material:

(i) as air or water borne effluent (other than sewerage); or

(ii) into the sewerage system.

Where radioactive material is to be disposed of in another way (other than release into the air, water, or sewerage system), an approval to dispose of the material must be obtained in accordance with the requirements of the Act. An approval to dispose would be required, for instance, if the proposed method of disposal of a radioactive material included depositing it at a waste disposal facility or burying it in soil.

It should also be noted that the proposed activity concentration levels for the disposal of radioactive material are to be much lower than those to be prescribed for the requirement to obtain a licence under the legislation. Consequently, the limits for disposal will apply not only to persons holding a possession licence, but also to other persons who may not be required to obtain a possession licence.

The reader may find it useful to refer to Appendix 2 for technical details about the way in which the proposed disposal limits were derived.

For radioactive materials that are to be disposed of either as air or water borne effluent, the proposed activity concentration limits are equivalent to the radionuclide activity concentration limits, which if inhaled, ingested or introduced into the body continuously over the period of one year, may yield an effective dose equal to 500 **microsieverts** (*μ***Sv**). The activity concentration limits that have been determined by this method are listed in Schedule 2 of this Legislative Proposal.

For radioactive materials that are to be disposed of into the sewerage system, the proposed activity concentration limits are equivalent to the radionuclide activity concentration limits, which if inhaled, ingested or introduced into the body continuously over the period of one year, may yield an effective dose equal to 1,000 microsieverts. The activity concentration limits that have been determined by this method are also set out in Schedule 2. These scenarios are very conservative, as it is unlikely that a person would derive their total water supply for one year from the sewerage system. It is also unlikely that a person would breathe solely air, or drink solely water, containing the concentrations of radioactive materials mentioned here.

The activity concentration limits for disposal are consistent with the National Health and Medical Research Council's (NHMRC) recommendation that the radiation dose for members of the public be limited to 1000 microsieverts per annum. Refer to the documents, Radiation Health Series 39, *Recommendations for limiting exposure to ionising radiation (1995) (Guidance note [NOHSC: 3022(1995)])* and *National Standard for limiting occupational exposure to ionising radiation [NOHSC: 1013(1995)]*.

The system of radiation protection described in the above NHMRC document does not specifically refer to other species or to the environment, though it is accepted internationally that by ensuring adequate standards for the protection of people, other species will thereby be adequately and acceptably protected from additional risk. It is important to note that, once released into the environment, the activity concentrations of the radionuclides will be reduced further in the disposal medium due to the processes of dilution, dispersion and nuclear decay. The proposed activity concentration limit for disposal into the sewerage system is higher than that for water, as it is recognised that the public has little access to the contents of the sewerage system until after significant dilution and its contents are released into the environment.

In summary, it is proposed that radioactive material may be disposed of into air, water or the sewerage system, if it meets the following criteria:

(a) For disposal into air, the material must be gaseous or easily dispersed in air.

(b) For disposal into water or the sewerage system, the material must be readily soluble or easily dispersed in water.

(c) The material contains a radionuclide specified in Column 2 of Schedule 2, and the activity concentration of the radionuclide in the material does not exceed the activity concentration for the radionuclide specified in Column 4, Column 5 or Column 6 (depending on the disposal medium) of Schedule 2.

(d) The material contains a mixture of more than one radionuclide specified in Column 2 of Schedule 2 and the **disposal factor of** the mixture does not exceed the value of one (1). The calculation for the disposal factor is given in Appendix 3. An example of how this calculation may be applied is provided in Appendix 4.

When radioactive material is disposed of into the sewerage system, the point of disposal at which the activity concentration of the radionuclide in the material is to be decided, shall be the point at which the sewerage pipe from the premises at which the radiation practice is carried out joins the sewerage main reticulation line.

OTHER REQUIREMENTS FOR DISPOSAL OF RADIATION SOURCES

Under the *Radiation Safety Act 1999* a regulation may also be made about the disposal of—

- radiation sources (ie. a radioactive substance or radiation apparatus);
- containers that have been used for the transport or storage of radioactive material; or
- apparatus that once contained a sealed radioactive substance.

It is intended that a regulation be made about the disposal of the following—

(a) a container that has been used to store radioactive material;

(b) a container that has been used for the transport of radioactive material;

(c) an apparatus that once contained a sealed radioactive substance; or

(d) a radiation apparatus.

The regulation will state that a person must, at the time of disposal, remove or make illegible all radiation warning signs attached to the container, the equipment, gauge, instrument, device, or apparatus.

It is proposed that the regulation will also state that a container that has been used for the transport or storage of radioactive material or an apparatus that once contained a sealed radioactive substance, must not be disposed of unless:

(a) the radionuclide contamination of the container or apparatus is not more than 4 Bq per square centimetre; or

(b) where the container or apparatus is contaminated by a radionuclide that emits alpha particles having a half-life greater than three months, the contamination is not more than 0.4 Bq per square centimetre.

RADIATION SAFETY AND PROTECTION PLANS

The *Radiation Safety Act 1999* imposes important obligations on a possession licensee who possesses a radiation source for a radiation practice. As part of the process of obtaining a possession licence, a person is required to develop a radiation safety and protection plan. Furthermore, a possession licensee must take reasonable steps to ensure that a person does not carry out a radiation practice on their behalf, unless that person has available for inspection a copy of their approved radiation safety and protection plan for the practice, and has undergone the training program provided for in the plan.

The Act imposes a similar obligation on a person carrying out a radiation practice. Wherever a possession licensee possesses a radiation source for a radiation practice, any person intending to carry out the practice with that source must not carry out the practice unless they have available for inspection, a copy of the approved radiation safety and protection plan for that practice. The person must also undergo any training program mentioned in the plan, prior to carrying out the radiation practice.

A radiation safety and protection plan must be approved by the chief executive of Queensland Health and must state the following:

(a) particulars, and an assessment, of all the radiation hazards specific to the practice and source the licensee knows, or ought reasonably to know, exist or might arise;

(b) the radiation safety and protection measures to deal with the hazards;

(c) any other measures necessary to deal with the hazards;

(d) how the licensee proposes to monitor and review the implementation and effectiveness of the measures;

(e) the functions of the radiation safety officer to be appointed for the practice;

(f) the functions of the radiation safety officer to be appointed for the practice;

(g) particulars of a training program for persons carrying out the practice; and

(h) other particulars prescribed under a regulation.

RADIATION SAFETY AND PROTECTION MEASURES

As discussed above, a radiation safety and protection plan must contain the radiation safety and protection measures to deal with the hazards associated with a particular radiation practice.

Radiation safety and protection measures are defined under the *Radiation Safety Act 1999* as measures, prescribed under a regulation, for preventing or minimising health risks to any person arising from exposure to radiation from the carrying out of a radiation practice.

Accordingly, it is proposed that the regulation will set out the measures which must be addressed in a possession licensee's radiation safety and protection plan, as detailed below.

Working Procedures

The plan must include the working procedures for carrying out the radiation practice. As a minimum the following topics must be covered:

(i) safe handling procedures for the radiation sources involved;

(ii) safe work methods to minimise exposure to radiation, such as the use of time, distance from the source and shielding for ionising radiation, or beam stops, non-combustible, non-specularly reflecting surfaces for non-ionising radiation;

(iii) procedures for ensuring safety in the operation of the radiation source, including the use of **ancillary equipment**, personal protective equipment and safety devices; and

(iv) the quality control procedures which are to be undertaken in relation to the radiation sources and ancillary equipment.

Ancillary equipment includes equipment such as radiographic developing and processing equipment, radiograph viewing boxes, gamma cameras, industrial radiography windout mechanisms, transport containers, ventilation systems, etc.

Remediation Procedures

The plan must identify the range of **unintended events** that may reasonably be expected to occur when carrying out a particular radiation practice and the remediation procedures for dealing with each of these events. These procedures must detail those matters which must be addressed immediately the event occurs and subsequent to the event.

Unintended events means any unintended event, including operating errors, equipment failure or other mishaps, the consequences or potential consequences of which are not negligible from the point of view of radiation protection or safety. For example, spillage of a radioactive substance in a laboratory or the destruction of a soil moisture/density gauge during a vehicle accident.

Control of Contamination

For premises where unsealed radioactive substances are used or stored, the plan must specify how the premises, equipment within the premises, and personnel are to be monitored to detect or minimise the extent of radioactive contamination. This must include reference to using monitoring equipment with appropriate sensitivity, accuracy, range, and energy response for the potential radioactive contaminants.

The plan must also specify how, and the period for which, contaminated clothing, cloth, bandages or other things must be stored prior to their release to a laundry or other cleaning establishment.

Procedures for Handling Waste Radioactive Material

For radiation practices involving unsealed radioactive substances, the plan must specify how the possession licensee will store or otherwise deal with waste radioactive material prior to its disposal. In particular the plan must detail the methods by which the activity and volume of the radioactive wastes are to be minimised. Further, if the waste radioactive material is to be stored, the plan must specify that the waste must be segregated in accordance to half life, concentration, volume and physical and chemical properties.

Control of Access to Radiation Sources

The plan must specify how access to, or use of, the radiation source is to be controlled.

Provision of Safety Devices

The plan must specify the safety devices which must be provided by the possession licensee, and which must be used when carrying out a radiation practice, to reduce the radiation exposure to persons. For example, a safety device to be provided in relation to radioactive substances may include remote handling tools, shielded work benches, movable lead screens, lead

syringes, and shielded bins; and for radiation apparatus a safety device might include warning lights, timers, interlocks and fire extinguishers.

Provision of Personal Protective Equipment

The plan must specify the personal protective equipment, which is to be provided by the possession licensee and worn or otherwise used by persons who carry out a radiation practice, or assist in the carrying out of a radiation practice. Personal protective equipment includes, for example, lead aprons, thyroid collars, lead glasses, lead sleeves, protective eyewear, breathing apparatus, special clothing requirements.

The plan must also specify:

(i) the frequency with which personal protective equipment is to be checked for wear and tear, and correct operation; and

(ii) who is to perform these checks.

Provision of Personal Alarm Dosemeters

For those radiation practices which involve ionising radiation, the plan must specify whether **personal alarm dosemeters** are to be provided by the possession licensee. Personal alarm dosemeter means a personal radiation monitoring device that produces a visual or an audible signal when the radiation dose or the radiation dose rate exceeds the predetermined limits.

The plan must also specify:

(i) to whom the dosemeters must be provided;

(ii) how and when the dosemeters are to be used;

(iii) taking into account the radiation to be measured, the appropriate range, sensitivity, accuracy and energy response for personal alarm dosemeters;

(iv) the intervals at which dosemeters are to be checked to ensure correct operation, provided that such intervals are no greater than 12 months;

(v) if a dosemeter is damaged and repaired, or suspected to be damaged, the dosemeter must not be used until such time as it has been checked to ensure that it is operating correctly; and

(vi) who is to perform these checking procedures.

Personal Radiation Monitoring Devices

Under section 28(3) of the Act, a radiation safety and protection plan must provide for certain persons to be supplied with a personal monitoring device and for the assessment of the device. As discussed later in this paper, it is intended that such devices be provided to, and worn by, a person (other than a person undergoing a diagnostic or therapeutic procedure) who is likely to receive an effective dose greater than 1mSv in a year as a result of a radiation practice being carried out.

It is also proposed that the plan must detail:

(i) who is to wear these personal radiation monitoring devices;

(ii) how the devices are to be worn;

(iii) when and where the devices are to be worn;

(iv) where the devices are to be placed when not worn;

(v) the frequency with which they are to be assessed; and

(vi) who is to perform the assessment of the devices.

Radiation Monitoring Equipment

For those radiation practices which involve radioactive substances or ionising radiation apparatus, the plan must specify the radiation monitoring equipment to be provided by the possession licensee. The equipment provided must have the appropriate range, sensitivity, accuracy and energy responses for the radiation to be measured. Such monitoring equipment might include, for example, radiation survey meters or area radiation monitors.

The plan must also specify:

(i) how the monitoring equipment is to be used;

(ii) how the possession licensee intends to ensure that the radiation monitoring equipment continues to function in accordance with the required range, sensitivity, accuracy and energy responses;

(iii) the intervals at which such equipment is to be checked to ensure its correct operation, provided that such intervals are no greater than 12 months;

(iv) if the equipment is damaged and repaired, or suspected to be damaged, the equipment must not be used until such time as it has been checked to ensure that it is operating correctly; and

(v) who is to perform this checking procedure.

Medical Surveillance

For those radiation practices which involve Class IV lasers for health related or cosmetic procedures, the plan must specify those persons who are required to undertake eye and skin medical examinations.

In particular, the plan must specify where a person, who is involved in the carrying out of a radiation practice with a class IV laser, is employed by the possession licensee, an eye examination must be undertaken at the commencement and termination of that person's employment with the licensee. For example, use licensees employed in a hospital; nurses or other persons assisting a use licensee to carry out the practice.

The plan must also specify the tests to be used to examine the eye, as well as the frequency of examinations.

Control of Radiation Dose to Patients

For all radiation practices which involve the irradiation of another person for diagnostic, therapeutic or cosmetic purposes, the plan must specify the protective equipment to be provided by the possession licensee, which will minimise the radiation dose to the other person (ie. the patient).

The plan must also specify that the use licensee carrying out the procedure is responsible for ensuring that protective equipment is worn or otherwise used by the person undergoing the procedure.

The protective equipment must be appropriate for the diagnostic, therapeutic or cosmetic procedure concerned and might include, for example, lead aprons, thyroid collars, gonad shields, and protective eyewear.

Marking of Images

For those radiation practices which involve the irradiation of persons for diagnostic or therapeutic purposes and which result in the production of **radiographs** or **nuclear medicine scans** (or **images**), the plan must specify that the images produced are to be marked with certain information to assist in diagnosis; to uniquely identify the image as belonging to a

particular person; and to prevent unnecessary radiation exposure to patients (for example when patients are required to undergo repeat exposures). Images must be marked in such a way as to leave a permanent record on the image. The plan must specify the way in which this is to be achieved.

The plan must also specify that a use licensee who carries out diagnostic radiography, nuclear medicine or radiation therapy involving the irradiation of another person, must ensure that any image produced is marked with the following information:

(i) All radiographs with a surface area of 250 square centimetres or greater must be permanently marked with the following information:

- Name of the use licensee who took the radiograph.
- Name of the organisation or hospital at which the radiation practice was carried out.
- Name and date of birth of the person of whom the radiograph was taken.
- Date that the radiograph was taken.
- Radiographic parameters used to produce the radiograph (ie. values for kilovoltage, current and time).
- Orientation of the image (eg. left or right) and the patient (eg. prostrate or supine).

(ii) All nuclear medicine images must be permanently marked with the following information:

- Name of the use licensee who performed the nuclear medicine scan.
- Name of the organisation or hospital at which the radiation practice was carried out.
- Name and date of birth of person, the subject of the nuclear medicine scan.
- Date that the nuclear medicine scan was taken.
- Radiopharmaceuticals administered to the patient for image production.

- Marking indicating the orientation of the image.

Records About Irradiation of Persons

Where a possession licensee possesses a radiation source that will be used for the irradiation of persons for diagnostic or therapeutic procedures, a record about the use of the source must be maintained. It is becoming increasingly important for a number of radiation safety and medico-legal reasons that accurate records of the irradiation of a person are kept. To assist this, the plan must specify that the possession licensee is to keep the following details in a register and that entries in the register are to be made by the use licensee each time a person is exposed to radiation:

(i) Date of use of the radiation source.

(ii) Operating parameters used (ie. the values for kilovoltage, current and time) where the radiation source is a radiation apparatus.

(iii) Radionuclides administered and/or used.

(iv) Activity of each radionuclide administered and/or used.

(v) Comments about each exposure (eg. repeat due to movement of patient; radiographs too dark due to incorrect kilovoltage selection).

Exposure to Radon 222

The plan must specify the ventilation requirements for radiation practices where the concentration of the radioactive substance Radon 222 may exceed 200 Bq per cubic metre.

Maintenance of Records

The plan must detail how and where the following records are to be kept by the possession licensee:

(i) name of the person who used the radiation source to carry out the radiation practice;

(ii) particulars of the radionuclides that have been disposed of and the method of disposal;

(iii) particulars of the **quality control procedures** undertaken on the radiation source and the ancillary equipment, as well as the outcomes of these quality control assessments; and

(iv) periodic eye assessment records for persons involved in using Class IV lasers for health related or cosmetic purposes.

Quality control procedures means periodic evaluation to ensure that the radiation source and ancillary equipment are functioning optimally.

OTHER PARTICULARS

As well as radiation safety and protection measures, a plan must also state other particulars, which have been prescribed under a regulation.

Accordingly, it is proposed that the regulation require that a radiation safety and protection plan specify the frequency with which the radiation safety officer is to monitor or conduct an assessment of the radiation source or premises, to confirm continued compliance with the radiation safety standards.

RADIATION SAFETY OFFICERS

QUALIFICATIONS

Under the *Radiation Safety Act 1999*, a possession licensee must ensure that a radiation safety officer is appointed and is carrying out the functions of a radiation safety officer, whenever a radiation practice is carried out with a radiation source possessed by the licensee. Only a qualified person who holds a radiation safety officer certificate relevant to the radiation practice being carried out may be appointed as a radiation safety officer for that practice. However, a possession licensee (who is an individual) may appoint him or herself as a radiation safety officer, if:

(a) he or she holds a radiation safety officer certificate granted by the chief executive of Queensland Health under the *Radiation Safety Act 1999*; or

(b) he or she holds a qualification, relevant to the practice, prescribed under a regulation.

Qualifications are to be prescribed under the regulation in relation to the following radiation practices:

Radiation Practice	**Qualification**
Diagnostic Radiography: Intra-oral radiography of the teeth and facial bones	Persons who are registered as dentists under the *Dental Act 1971* and hold a degree in dentistry which was awarded, in or after 1988, by one of the following Australian universities: • University of Adelaide • University of Melbourne • University of Queensland • University of Sydney • University of Western Australia Persons who are registered as dentists under the *Dental Act 1971* and hold a certificate of proficiency in intra-oral radiography of the teeth and facial bones awarded by the University of Queensland Dental School.

Radiation Practice	**Qualification**
Diagnostic Radiography: Plain film radiography of the neuromusculoskeletal system	Persons who are registered as chiropractors under the *Chiropractors and Osteopaths Act 1979* and who hold a degree or diploma in chiropractic which was awarded, in or after 1984, by the Royal Melbourne Institute of Technology; the Philip Institute of Technology, Melbourne; or the Macquarie University, Sydney.
Veterinary Diagnostic Radiography	Persons who are registered as veterinary surgeons under the *Veterinary Surgeons Act 1936* and who hold a qualification listed in Part 1 of Schedule 2 of the *Veterinary Surgeons Regulation 1991*.

FUNCTIONS

Section 37 of the *Radiation Safety Act 1999* sets out the functions of a radiation safety officer. One of these functions is to provide, or arrange for the provision of, training about radiation hazards and safe working practices to—

(a) persons carrying out the radiation practice; and

(b) the possession licensee's employees and other persons working for the licensee who may be exposed to radiation emitted from the source; and

(c) other persons prescribed under a regulation.

It is proposed that a regulation should prescribe the following as "other persons" to whom the radiation safety officer must provide this training:

- Members of the public who are to assist a use licensee to carry out a diagnostic or therapeutic procedure, involving the use of ionising radiation. This category is intended to cover persons known as "comforters", who may be required to hold a young child (for example) undergoing diagnostic radiography.
- Persons who are to observe the carrying out of a radiation practice. For example, a person who is enrolled in a prescribed training course who, as part of their training, is required to observe the use of a particular radiation source.

DIAGNOSTIC AND THERAPEUTIC PROCEDURES INVOLVING THE IRRADIATION OF PERSONS

AUTHORISED PERSONS

For the purposes of section 41 of the *Radiation Safety Act 1999*, only certain persons may prescribe a therapeutic procedure for another person, or request a diagnostic procedure for another person, if these procedures will involve the irradiation of the other person.

The persons that may prescribe these therapeutic procedures or request these diagnostic procedures will be **authorised persons** for the legislation.

The following table specifies who are proposed as authorised persons for either diagnostic or therapeutic procedures.

Diagnostic Procedure	**Therapeutic Procedure**	***Authorised Person***
Intra oral and extra oral radiography of the teeth and facial bones		Persons registered as dentists under the *Dental Act 1971*
Intra oral bite wing radiography		Persons who are school dental therapists performing radiography in accordance with Queensland Department of Health's Oral Health Unit Policy on Consent Procedures
Extra oral radiography of the teeth and facial bones		Persons registered as dentists under the *Dental Act 1971*

Diagnostic Procedure	**Therapeutic Procedure**	***Authorised Person***
Plain flim radiography		Persons registered as medical practitioners under the *Medical Act 1939* Persons registered as registered nurses under the *Nursing Act 1992*, where they are: (a) employed at a public sector health service which has a protocol for nurse initiated X-rays approved by the chief executive, in accordance with the chief executive's powers under section 59 of the *Health Services Act 1991*; and (b) approved to request X-rays in accordance with the protocol for the hospital at which they are employed.
Plain film radiography, computed tomography, fluoroscopy, mammography and bone densitometry		Persons registered as specialists in the field of diagnostic radiology under the *Medical Act 1939*
Fluoroscopy		Persons registered as specialists under the *Medical Act 1939*
Bone densitometry		Persons registered as medical practitioners under the *Medical Act 1939*
Plain film radiography of the neuromusculoskeletal system		Persons registered as chiropractors under the *Chiropractors and Osteopaths Act 1979*

Diagnostic Procedure	**Therapeutic Procedure**	***Authorised Person***
	Radiation treatment of cancer	Persons registered as specialists in the field of radiation oncology under the *Medical Act 1939*
	Radiation treatment of skin lesions	Persons registered as specialists in the field of dermatology under the *Medical Act 1939*
	Radiation treatment of eye lesions	Persons registered as specialists in the field of ophthalmology under the *Medical Act 1939*
	Treatment of benign conditions involving the administration of unsealed radioactive substances	Persons registered as specialists in the field of nuclear medicine under the *Medical Act 1939*
Diagnostic nuclear medicine		Persons registered as specialists in the field of nuclear medicine under the *Medical Act 1939*
	Radiation treatment of thyroid conditions	Persons registered as specialists in the field of endocrinology under the *Medical Act 1939*
	Radiation treatment of synovectomy	Persons registered as specialists in the field of rheumatology under the *Medical Act 1939.*
	Radiation treatment of vascular stenosis	Persons registered as specialists in the field of cardiology or vascular surgery under the *Medical Act 1939*

Diagnostic Procedure	**Therapeutic Procedure**	***Authorised Person***
	In vivo pathological tests	Persons registered as specialists in the field of pathology under the *Medical Act 1939*
Health related diagnostic procedures involving Class IV lasers for health related purposes	Health related therapeutic procedures involving Class IV lasers for health related purposes	Persons registered as medical practitioners under the *Medical Act 1939* and persons registered as dentists under the *Dental Act 1971*.

PERSONAL RADIATION MONITORING

Section 38 of the *Radiation Safety Act 1999* sets out requirements in relation to the conduct of a personal radiation monitoring program for the following persons:

- a person who has been provided with (and wears) a personal monitoring device by a possession licensee, as required under the licensee's approved radiation safety and protection plan for a radiation practice (eg a diagnostic radiographer in a hospital);
- a possession licensee who is required to be provided with (and wear) a personal monitoring device under their approved radiation safety and protection plan for a radiation practice (eg an owner-operator of a soil moisture gauge);
- a use licensee who, as a condition of their licence, is required to wear a personal monitoring device when using a radiation source to carry out a radiation practice under the licence (eg a visiting diagnostic radiologist).

This section of the Act also requires that an up-to-date personal monitoring record be kept for each person required to wear a personal monitoring device. This record is to be comprised of the results of all assessments of the personal monitoring devices worn by a person as well as information prescribed under a regulation. Accordingly, it is proposed that the regulation specify that a personal monitoring record should contain the following information:

(i) the postal address of the possession licensee where a personal monitoring device is provided to a monitored person in accordance with a possession licensee's radiation safety and protection plan; or the postal address of the use licensee who is required to wear a personal monitoring device as a condition of their licence;

(ii) the full name of the monitored person;

(iii) the gender of the monitored person;

(iv) the date of birth of the monitored person;

(v) the place at which the radiation practice, the subject of the possession licensee's licence, was carried out;

(vi) the date the monitoring of the person commenced;

(vii) the date of the last assessment of the monitored person or the date the person ceased being monitored;

(viii) the capacity in which the person was monitored (eg. use licensee, volunteer, comforter);

(ix) particulars of the type of radiation to which the monitored person may have been exposed;

(x) the effective doses and cumulative effective doses received by the monitored person;

(xi) the period the person wore the personal monitoring device prior to each assessment;

(xii) particulars about the methodology used to conduct the assessment of the monitored person; and

(xiii) the estimated effective dose received by the monitored person as a result of a dangerous event (other than where the radiation source is lost or stolen).

In relation to point (xiii) above, where a possession licensee possesses a radiation source for a radiation practice, a dangerous event is defined in the Act as occurring when:

(i) the source is, or appears to have been, lost or stolen;

(ii) there is a radiation incident in relation to the source, for which there are no remediation procedures stated in the licensee's approved radiation safety and protection plan for the practice being carried out with the source at the time;

(iii) equipment that uses, measures or controls radiation emitted from the source malfunctions with the result, or likely result, that there is, or will be, an unintended emission of the radiation or a person is, or will be, unintentionally exposed to the radiation.

A radiation incident means an incident adversely affecting, or likely to adversely affect, the health or safety of any person because of the emission of radiation.

Remediation procedures, for a radiation incident, means procedures designed to minimise the radiation hazard arising from the incident.

RADIATION DOSE LIMITS

Throughout the *Radiation Safety Act 1999*, obligations are imposed on certain persons to ensure that, under specified circumstances:

(a) a person is not exposed to radiation in excess of a prescribed radiation dose limit; or

(b) measures are taken to prevent, or minimise the likelihood that, a person would be exposed to radiation in excess of a prescribed radiation dose limit.

For the purposes of the legislation, radiation dose limit is defined as meaning:

(a) for ionising radiation, a limit on the radiation dose a person may receive during a particular period; or

(b) for radioactive material, a limit on the amount of the radionuclide in the material that may be inhaled, ingested or introduced into the body of a person during a particular period; or

(c) for non-ionising radiation, a limit on the radiation dose a person may receive during a particular period.

CLASSIFICATION OF EXPOSURES TO IONISING RADIATION

In accordance with national and international protocols, the regulation will deal with exposure to ionising radiation in the following contexts: occupational, health related and public.

Occupational exposure is to be defined as meaning exposure of a person to radiation which occurs in the course of that person's work and which is not excluded exposure. Excluded exposure, in this context refers to the component of exposure that arises from natural background radiation, except when such exposure is a direct consequence of a radiation practice (eg the processing of **minerals containing radionuclides**).

Health related exposure is to be defined as meaning exposure of a person to radiation received as a patient undergoing medical or dental diagnosis or therapy.

Public exposure is to be defined as meaning exposure of a person, or persons, to radiation which is neither occupational nor health related.

DOSE LIMITS FOR EXPOSURE TO IONISING RADIATION

Radiation dose limits for ionising radiation, which are to be prescribed in the regulation, were developed with regard to the dose limits detailed in Schedule A of the *Recommendations for limiting exposure to ionizing radiation* (1995) (Guidance note [NOHSC: 3022(1995)]) and *National standard for limiting occupational exposure to ionizing radiation* [NOHSC:1013(1995)]), Radiation Health Series 39, AGPS, Canberra; and Schedule II Safety Series No.115, *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources*, International Atomic Energy Agency, Vienna, 1996.

Radiation dose limits are to be specified in terms of **equivalent dose** and **effective dose.**

Equivalent dose is the weighted absorbed dose in an organ or tissue of the body, taking into account the type of radiation involved. Weighted absorbed dose is the product of the energy absorbed per unit mass by an organ or tissue from a source of ionising radiation and the radiation weighting factor specified in Table 1, Recommended radiation weighting factors, of the *Recommendations for limiting exposure to ionizing radiation* (1995) (Guidance note [NOHSC: 3022(1995)]).

Effective dose is the sum of the weighted equivalent doses in all organs and tissues of the body. Weighted equivalent dose is the product of the equivalent dose in an organ or tissue and the weighting factor for that organ or tissue specified in Table 2, Recommended tissue weighting factors, of the *Recommendations for limiting exposure to ionizing radiation* (1995) (Guidance note [NOHSC: 3022(1995)]).

A person's effective dose for a **specified period** is the sum of:

(a) the effective dose that the person receives, from **external exposure**, during the specified period; and

(b) the person's **committed effective dose**, received from intakes of radionuclides during the specified period, for the next 50 years if the person is over 18 years of age or for the next 70 years if the person is under 18 years of age.

The specified period over which a person's effective dose is calculated will vary depending on whether or not that person is occupationally exposed to ionising radiation. That is, the specified period for the calculation of the

effective dose of an occupationally exposed person is 5 consecutive years; whereas the period for the calculation of the effective dose of a member of the public is 1 year.

External exposure is to be defined as meaning irradiation from sources of ionising radiation outside the body.

Committed effective dose is to be defined as meaning the effective dose that an individual is committed to receive from an intake of radioactive material over the period subsequent to that intake. As indicated above, for individuals over 18 years of age an integration period of 50 years is assumed, where as a period of 70 years is assumed for individuals under the age of 18. A child's committed effective dose must be worked out on the basis of the number of years calculated by subtracting the person's age, at the time of the calculation, from 70.

Occupational Exposure

The radiation dose limits for the occupational exposure of a person who carries out a radiation practice are as follows:

(a) The effective dose received by the person must not exceed 20 mSv annually, averaged over 5 consecutive calendar years. However, in any year, the effective dose received by the person must not exceed 50 mSv.

(b) The equivalent dose limit to the lens of the eye must not exceed 150 mSv annually.

(c) The equivalent dose limit to the hands and feet must not exceed 500 mSv annually.

(d) The equivalent dose limit to the skin must not exceed 500 mSv annually. The annual equivalent dose limit to the skin applies to the average dose received by any 1 cm^2 of skin, regardless of the total area exposed.

The radiation dose limits for the occupational exposure of an employee or agent of a possession licensee who does not carry out a radiation practice but because of their work may be exposed to ionising radiation emitted from a radiation source possessed by the licensee are as follows:

(a) The effective dose received by the person must not exceed 1 mSv in a year.

(b) The equivalent dose limit to the lens of the eye must not exceed 15 mSv annually.

(c) The equivalent dose limit to the skin must not exceed 50 mSv annually. The annual equivalent dose limit to the skin applies to the average dose received by any 1 cm^2 of skin, regardless of the total area exposed.

Public Exposure

The radiation dose limits for the public exposure or a person are as follows:

(a) The effective dose received by a member of the public must not exceed 1 mSv in a year. That is, with the exception of a member of the public who assists a use licensee to carry out a diagnostic or therapeutic procedure involving the use of ionising radiation. For example a parent who assists a use licensee by holding their child's arm in the correct position so that it maybe radiographed or a parent who comforts their child undergoing treatment for a thyroid condition using Iodine 131. Under these circumstances, the effective dose must not exceed 5 mSv in a year.

(b) The equivalent dose limit to the lens of the eye must not exceed 15 mSv annually.

(c) The equivalent dose limit to the skin must not exceed 50 mSv annually. The annual equivalent dose limit to the skin applies to the average dose received by any 1 cm^2 of skin, regardless of the total area exposed.

When a female who is occupationally exposed declares that she is pregnant, the embryo or foetus should be afforded the same level of protection as required for a member of the public. That is, from the time the woman declares she is pregnant, the radiation dose limit for the embryo or foetus should be consistent with the effective dose limit specified for a member of the public.

Exposure of Volunteers in Biomedical Research

Radiation dose limits for volunteers in biomedical research apply to volunteers who do not themselves benefit from the exposure to the radiation.

The radiation dose limits for the exposure of a volunteer in biomedical

research are as follows:

(a) The effective dose received by a person over the age of 18 years, must not exceed 10 mSv over 5 consecutive calendar years. However, in any year, the effective dose received by the person must not exceed 5 mSv.

(b) The effective dose received by a person 18 years of age and younger, must not exceed 5 mSv over the period until the person reaches the age of 18 years.

In relation to the prescribed radiation dose limits for ionising radiation, the following circumstances will apply:

- A radiation safety and protection plan for a radiation practice must provide for the supply and assessment of a personal monitoring device, when there is the possibility that a person is likely to receive an effective dose greater than 1 mSv in a year as a result of a person carrying out the practice. For example, if it is envisaged that a nurse working in a ward taking care of patients undergoing radiation therapy may receive an effective dose greater than 1 mSv in a year, the radiation safety and protection plan must specify that the nurse be provided with a personal monitoring device. However, this requirement does not relate to a person undergoing a diagnostic or therapeutic procedure involving the use of radiation. Refer to section 28(3) of the *Radiation Safety Act 1999*.
- As provided for in section 37(2)(c)(i) of the Act, a function of the radiation safety officer is to provide, or arrange for the provision of, training to persons about precautions that need to be taken to ensure that, for ionising radiation, radiation doses received from the source are below the radiation dose limits prescribed under a regulation. Radiation dose limits will be prescribed for the following specified persons:
  - (i) An occupationally exposed person.
  - (ii) A member of the public.
  - (iii) An embryo or foetus, where a female who is occupationally exposed declares that she is pregnant.
  - (iv) A member of the public who assists a use licensee to carry

out a diagnostic or therapeutic procedure involving the use of ionising radiation.

- A use licensee who is carrying out a diagnostic or therapeutic procedure involving the use of ionising radiation must not allow either an occupationally exposed person involved in carrying out the procedure or a member of the public, who assists the licensee to carry out the procedure, to receive a radiation dose higher than the radiation dose limit to be prescribed for each of these categories of persons. Also, where a female who is occupationally exposed as a result of her involvement in the carrying out of a diagnostic or therapeutic procedure, and has declared that she is pregnant, the level of protection afforded to the embryo or foetus should be consistent with the effective dose limit specified for a member of the public. Refer to section 41(5) of the Act.
- Section 42(2) of the Act provides that a person carrying out a radiation practice with a source must not cause another person to receive a radiation dose higher than the radiation dose limit prescribed under a regulation. Radiation dose limits for ionising radiation will be prescribed for the following specified persons:
  - (i) An occupationally exposed person.
  - (ii) A member of the public.
  - (iii) A volunteer in biomedical research.
  - (iv) An embryo or foetus, where a female who is occupationally exposed declares that she is pregnant.
  - (v) A member of the public who assists a use licensee to carry out a diagnostic or therapeutic procedure involving the use of ionising radiation.
- Under section 127(1)(b) of the Act, an inspector may seize a thing, if the inspector reasonably believes it is the cause or likely cause of a radiation hazard which cannot be managed in a way to ensure that a person will not receive a radiation dose higher than the radiation dose limit specified for:
  - (i) An occupationally exposed person.
  - (ii) A member of the public.

(iii) A volunteer in biomedical research.

(iv) An embryo or foetus, where a female who is occupationally exposed declares that she is pregnant;

(v) A member of the public who assists a use licensee to carry out a diagnostic or therapeutic procedure involving the use of ionising radiation.

RADIATION DOSE LIMITS FOR NON-IONISING RADIATION

Radiation dose limits for non-ionising radiation, which are to be prescribed under the regulation, will be consistent with the exposure limits specified in the following tables of the Australian/New Zealand Standard AS2211.1: 1997 *Laser Safety Part 1: Equipment Classification, Requirements and User's Guide (1997):*

- Table 7, Maximum Permissible Exposure (MPE) At The Cornea For Direct Ocular Exposure To Laser Radiation; and
- Table 8, Maximum Permissible Exposure (MPE) Of Skin to Laser Radiation.

In relation to the prescribed radiation dose limits for Class IV lasers used for health related or cosmetic procedures, the following circumstances will apply:

- As provided for in section 37(2)(c)(ii) of the Act, a function of the radiation safety officer is to provide, or arrange for the provision of, training to persons about precautions that need to be taken to ensure that, for non-ionising radiation, radiation doses received from the source are below the radiation dose limits prescribed under a regulation. A radiation safety officer will be required to provide, or arrange for the provision of, training to specified persons about the precautions that need to be taken to ensure radiation doses received by these or other persons are below the maximum permissible exposure specified in AS2211.1: 1997.
- A use licensee who is carrying out a diagnostic or therapeutic procedure involving the use of Class IV lasers for health related or cosmetic procedures must not allow a person, other than the person being treated, to receive a radiation dose in excess of the maximum permissible exposure specified in AS2211.1: 1997. Refer to section 41(5) of the Act.

- A person carrying out a radiation practice with a Class IV laser for health related or cosmetic procedures must not cause another person to receive a radiation dose higher that the maximum permissible exposure specified in AS2211.1: 1997. Refer to section 42(2) of the Act.
- Under section 127(1)(b) of the Act, an inspector may seize a thing, if the inspector reasonably believes it is the cause or likely cause of a radiation hazard which cannot be managed in a way to ensure that a person will receive a radiation dose lower than the maximum permissible exposure specified in AS2211.1: 1997.

EXEMPTIONS

EXEMPTION OF PERSONS

Prescribed Radiation Practices

Under section 13(2)(b)(i) of the *Radiation Safety Act 1999*, a person is exempt from the requirement to hold a use licence, if:

(a) the person is using a radiation source in the presence, and under the personal supervision, of a use licensee who is allowed, under the licence, to use the source to carry out a radiation practice; and

(b) the use is for the purpose of helping the licensee to carry out the practice, if the practice is a prescribed radiation practice.

A prescribed radiation practice means a radiation practice, other than the carrying out of a diagnostic or therapeutic procedure involving the irradiation of another person, prescribed under a regulation.

It is proposed that the regulation will specify that the following practices are prescribed radiation practices:

- industrial radiography involving radiation sources;
- **borehole logging** involving sealed radioactive substances;
- preparation of radiopharmaceuticals using unsealed radioactive substances that is typically undertaken as part of, or in preparation for, nuclear medicine and radiation therapy procedures (eg. the labelling of pharmaceuticals with radionuclides)
- preparation or assembly of sealed radioactive substances for radiation therapy procedures;
- maintenance, servicing or repair of radiation sources;
- **compliance testing** of radiation sources;
- **quality control procedures** involving the use of radiation sources; and

Prescribed Training

Under section 13(2)(b)(ii) of the Act a person may be exempt from the requirement to hold a use licence if:

(a) the person is using a radiation source in the presence, and under the personal supervision, of a use licensee who is allowed, under the licence, to use the source to carry out a radiation practice; and

(b) the person is undergoing training prescribed by the regulation.

It is proposed that a person undergoing training in any of the following courses shall be exempt from the requirement to hold a use licence:

- Master of Applied Science—Medical Physics, Centre for Medical and Health Physics, Queensland University of Technology.
- An undergraduate or postgraduate course in nuclear medicine technology accredited by the Australian and New Zealand Society of Nuclear Medicine.
- Bachelor of Dental Science (BDSc)—Dental School, The University of Queensland.
- Bachelor of Oral Health (B Oral H)—Dental School, The University of Queensland.
- Academic Upgrade for School Dental Therapists—Dental School, The University of Queensland/Queensland University of Technology/Queensland Health (conducted jointly by the three organisations).
- Radiography Course for Dental Assistants—Dental School, The University of Queensland.
- Extra-Oral Radiography for Dentists—Dental School, The University of Queensland
- Re-Entry Course for School Dental Therapists—Oral Health Education Unit, Queensland Health.
- Veterinary Surgery A and Veterinary Surgery B—4th year; Bachelor of Veterinary Science—School of Veterinary Science and Animal Production, The University of Queensland.
- Semester 1, Medical Radiation Technology, Bachelor of Applied Science, Centre for Medical and Health Physics, Queensland University of Technology.

- Compliance testing of diagnostic imaging equipment training course, Medical Physics, Biomedical Engineering and Health Technology Services, Queensland Health.
- Laser concepts in health care, Australian Centre for Medical Laser Technology.

It should be noted that, although a person may be exempt from the requirement to obtain a use licence, they will still be bound by the provisions relating to the carrying out of a radiation practice. For example, under section 44 of the *Radiation Safety Act 1999* a person carrying out a radiation practice must take reasonable steps to ensure any person's health and safety are not adversely affected by exposure to radiation because of the way the person carries out the practice.

EXEMPTION OF RADIATION SOURCES

For the purposes of the legislation, a regulation may exempt a radiation source from the whole *Radiation Safety Act 1999*, or certain provisions of the Act. Exemptions cannot apply to radiation sources if the exemption could reasonably be expected to pose any, or more than negligible, health risks to any person.

It is proposed that the radiation sources listed below shall be exempt from the provisions of certain sections of the Act as stated. It is important to note that whilst a radiation source may be exempted from certain provisions of the Act, such as licensing, a person may still be required to comply with other provisions, such as disposal of the source or carrying out a radiation practice in accordance with a radiation safety and protection plan, and complying with a radiation safety standard made by the Minister for Health.

However, where a radiation source is to be exempt from the requirement that a person hold a possession licence (section 12 of the Act), then consequentially, the source is also exempt from section 18 (When a possession licensee must obtain certificate of compliance), section 23 (Who may acquire a radiation source), section 24 (Supply of radiation sources), and section 25 (Person must not relocate radiation source without approval) of the Act.

Radiation Sources Exempt From Use Licence Requirements

It is proposed that the radiation sources listed below be exempt for the purpose of section 13 (use) of the *Radiation Safety Act 1999*, on the basis that a source will be in the possession of a possession licensee who is allowed to use the source for the radiation practice. In effect, this would mean that a person who intends to use one of these sources will not be required to obtain a use licence to do so.

The requirement that a possession licensee must be allowed to possess the source to carry out the radiation practice will ensure that the source is covered by a certificate of compliance. Consequently, the sources will also be covered by the possession licensee's radiation safety and protection plan. This would mean for instance, that the possession licensee for the radiation source would still have an obligation to provide appropriate radiation safety training and instruction to the operators (ie. the users) of the source. Also, the possession licensee must ensure that the source continues to comply with the relevant radiation safety standard, while it is being used to carry out a radiation practice.

The radiation sources listed below require little or no operator skill to ensure radiation safety during their operation. This is because they have several in-built, engineered safety features, including mechanisms to prevent direct access to the radiation source. The risk associated with exempting the operators of these radiation sources from the requirement to hold a use licence is therefore considered to be negligible.

The radiation sources to be exempt are as follows:

- Sealed radioactive substance incorporated in a sealed source apparatus that is used for chemical analysis.
- **Enclosed radiation apparatus** that is used for chemical analysis. Enclosed radiation apparatus is a radiation apparatus which is wholly enclosed by interlocked barriers and/or shields and so designed that it can be used in ways which involve no possibility of exposure of any person to the primary X-ray beam.
- **Cabinet radiation apparatus** that is used for radiographic or fluoroscopic imaging of objects or goods. Cabinet radiation apparatus means a radiation apparatus as defined by the National Health and Medical Research Council's *Statement on cabinet X-ray equipment for examination of letters, packages, baggage,*

freight and other articles for security, quality control and other purposes (1987). This may include, for example, cabinet radiation apparatus used for baggage inspection, or for detection of foreign objects in meats.

- **Product irradiator** that uses a sealed radioactive substance for irradiating objects or materials. Product irradiation involves the exposure of an item, such as medical equipment, food, imported goods (eg. wooden artefacts, leather products), to an intense beam of radiation for sterilisation.
- Sealed radioactive substance incorporated in a sealed source apparatus that is used for industrial gauging.
- Radiation apparatus that is used for industrial gauging.
- Sealed radioactive substance that is used for **calibration** checks or quality control purposes and does not exceed a maximum activity of 370 **megabecquerels** (MBq).

  Calibration, in this instance, means the check or correction of the accuracy of a measuring instrument to assure proper operational characteristics.
- Sealed radioactive substance used as a **marker source** and which does not exceed a maximum activity of 4 MBq.

  Marker source means a radiation source that is used for transferring anatomical landmarks to images that are captured using a gamma camera. For example, the use of Cobalt 57 of activity 3.7 MBq, used as a marker source during nuclear medicine imaging of patients.
- Radioactive substances used for in vitro tests, provided the maximum activity radionuclide does not exceed 500 kBq per test. For example, the use of Iodine-125 for pathological analysis.

Radioactive Substances Exempt From Transport Licence Requirements

It is proposed that the radiation sources listed below be exempt from the requirement that a person hold a transport licence under sections 14 and 15 of the Act:

- Any radioactive substance that is transported as an **excepted package** in accordance with section 134 of the Commonwealth of

Australia's *Code of Practice for the Safe Transport of Radioactive Substances 1990*, issued under the provisions of the *Environment Protection (Nuclear Codes) Act 1978* (Cwlth) and published by the Australian Government Publishing Service, Canberra.

Excepted package is a package containing a limited quantity of radioactive material, which may or may not be contained in an instrument or a manufactured article, which will retain its contents under conditions likely to be encountered during routine transport, and which complies with the following:

- the radiation levels at the surface of the package do not exceed 5 μSv per hour;
- the radiation levels at 10cm from any point on the external surface of any unpackaged instrument or article do not exceed 0.1 mSv per hour;
- each instrument or article bears the marking "radioactive"; and
- a package not containing an instrument or article bears the marking "radioactive" on an internal surface so that it is visible on opening the package.

- A radioactive substance that is transported as an integral part of its use, provided that:

  (a) the substance is used by a person who is allowed to use the substance for the radiation practice; and

  (b) when packaged and transported, the substance meets the requirements for an excepted package under the *Code of Practice for the Safe Transport of Radioactive Substances 1990*.

An example of the type of radioactive substance to be covered by this exemption is a density/moisture gauge containing an Americium/Beryllium 241 source, which is typically used in the field to measure the percentage of moisture or density of soil, concrete, etc. Transportation of the source is an integral part of its use. The possession licensee's radiation safety and protection plan, for the use of this source when carrying out a radiation practice, will cover aspects relating to the packaging and transport of the

gauges. That is, it will require that the radiation source is packaged and transported in accordance with the *Code of Practice for the Safe Transport of Radioactive Substances 1990*.

The proposal to exempt this type of radiation source from the Act's requirements about transport licences does not pose any increased risk or hazard to either the user or to the public. Consequently, where a person has a use licence authorising him or her to use the source to carry out the practices in the scenarios below, the following radiation sources would be exempt under this provision. As mentioned above, a possession licensee's radiation safety and protection plan would address operational matters about the packaging and transport of these sources. It should also be noted that a person would still require a use licence to use any of the sources to carry out a radiation practice.

Where one of the following radioactive substances meets the conditions discussed above, it is to be exempt from the requirements of sections 14 and 15 of the Act:

- Sealed radioactive substance incorporated in a sealed source apparatus that is used to carry out borehole logging.
- Sealed radioactive substance incorporated in a sealed source apparatus that is used to carry out moisture/density measurements.
- Sealed radioactive substance incorporated in a sealed source apparatus that is used to carry out industrial radiography.
- Sealed radioactive substance that is used in a portable device to carry out chemical analysis.

Smoke Detectors

For this provision, **smoke detector** means an ionisation chamber smoke detector containing a radioactive substance as a component of the smoke detecting element. Smoke detectors have been categorised as follows:

(a) **Type A smoke detector** means a smoke detector that contains Americium 241 with an activity not greater than 37 kBq, and which has been manufactured in accordance with sections 2, 3 and 4 of the Australian Standard AS3786-1993 *Smoke Alarms* (2nd edition).

(b) **Type B smoke detector** means a smoke detector that contains Americium 241 with an activity greater than 37 kBq, or any other radionuclide.

Type A smoke detectors are predominantly used in domestic premises and some small business premises.

Type B smoke detectors may contain higher activities of Americium 241 than type A smoke detectors. Type B smoke detectors are generally found in structures larger than an average house, such as commercial and industrial premises.

Type B smoke detectors that contain radionuclides other than Americium 241 are not known to be manufactured to a specific standard and may be no longer sold in Queensland. However, these smoke detectors are still operational and serviced in many buildings. Such smoke detectors pose a negligible hazard in their present state. It is preferable that Americium 241 be used in smoke detectors, as it is less hazardous and more suitable for use in consumer products.

From 1 January 2000, type B smoke detectors which are brought into Queensland, and which do not comply with Australian Standard AS1603.2.1990 *Automatic fire detection and alarm systems Part 2: Point type smoke detectors*, will not be exempt from the provisions of the Act. This is to discourage the future acquisition and use of smoke detectors that do not comply with Australian Standard AS1603.2.1990.

Engineered safeguards employed in smoke detectors which comply with the relevant Australian Standards ensure that risks associated with the radioactive material within the detectors are minimal.

The Americium 241 is securely fixed in the smoke detector's ion chamber, and this source (within these types of smoke detectors) is resistant to most mechanical, chemical and thermal abuse. In addition, the alpha radiation from Americium 241 in a type A smoke detector poses a negligible external radiation hazard. In the unlikely possibility that a person ingested the radiation source, the insoluble americium oxide would pass through the body without delivering a significant radiation dose.

It is therefore considered appropriate to exempt smoke detectors from the various sections of the Act as follows:

- A Type A or type B smoke detector shall be exempt from the requirements of sections 12 and 13 of the Act (possession and use), provided that the smoke detector has been manufactured in accordance with the relevant Australian Standard, or (for type B smoke detectors) provided the detector was purchased before 1 January 2000.
- A type A smoke detector shall also be exempt from the requirements of section 26 of the Act (disposal of a radioactive material).

Where a smoke detector complies with the *Code of Practice for the Safe Transport of Radioactive Substances 1990*, it will be an excepted package and will therefore also be exempt from the requirements of sections 13 and 14 of the Act (transport by road and transport otherwise than by road).

The exemption from the requirements of sections 12 and 13 of the Act shall not apply to the repair of smoke detectors. In addition, it should be remembered that persons who manufacture smoke detectors in Queensland will be required to comply with the licensing requirements in relation to possession and use of any radioactive substances used in the manufacture of the smoke detectors.

Time Keeping Devices and Other Items that use radionuclides to produce light [3]

Time keeping devices and other items sometimes contain a radioactive source as part of a light producing element. These things can be classified as follows:

(i) Clocks and other time keeping devices, including those that are worn by a person, containing quantities of radioactive substances to produce light.

(ii) Other items using certain radioactive substances to produce light.

Time keeping devices under (a) above would include, for example, a watch incorporating a radioactive substance to light up the dial.

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[3] **Gaseous tritium light devices** are addressed separately, as the conditions for their exemption from the Act are distinct and separate from the conditions to be imposed by this provision.

Other items captured by (b) above might include certain marine compasses; certain thermostat dials and pointers; lock illuminators; and illuminated light switches.

Such time keeping devices and other items may involve the use of small quantities of radionuclides embodied in luminous paint. They are not considered to pose more than a negligible health risk to any person while in "normal" use.

It is therefore proposed that time keeping devices and other items containing the radioactive substances Promenthium 147, Radium 226 or Tritium 3 shall be exempt from the requirements of sections 12, 13, 14 and 15 of the Act (possession, use, transport by road, and transport otherwise than by road). They shall also be exempt from the requirements of section 26 of the Act (disposal of a radioactive material).

The exemption from the requirements of sections 12, 13, 14 and 15 of the Act shall not apply to the manufacture or repair of these time keeping devices and other items.

Gaseous Tritium Light Devices

A gaseous tritium light device is an instrument, piece of equipment, article or subassembly containing one or more sealed glass containers filled with gaseous tritium and coated internally with a phosphor. These devices produce light for many applications, typically safety related, for example as warning signs in underground mines. Tritium is a low energy beta radiation source and very few radiation particles emitted by the source escape the glass container surrounding it. Gaseous tritium light devices are therefore not considered to pose more than a negligible health risk to any person when in "normal" use.

It is proposed that a gaseous tritium light device shall be exempt from the requirements of sections 12 and 13 of the Act (possession and use), if the device—

(i) contains less than 74 GBq of tritium; and

(ii) is used solely for safety purposes; and

(iii) complies with sections 2, 4 and 5 of the *Recommendations for Exemptions from Licensing of Gaseous Tritium Light Devices*, Appendix 39, approved by the 81st session of the National Health and Medical Research Council (1975).

Where a gaseous tritium light device complies with the *Code of Practice for the Safe Transport of Radioactive Substances 1990*, it will be an excepted package and will therefore also be exempt from the requirements of sections 13 and 14 of the Act (transport by road and transport otherwise than by road).

The exemption from the requirements of sections 12 and 13 of the Act shall not apply to the manufacture or repair of gaseous tritium light devices.

Depleted Uranium

Depleted uranium refers to uranium that contains less than 0.72% of Uranium 235, which is the amount of that isotope found in naturally occurring uranium. Depleted uranium is obtained from used fuel elements or as by-product residues from uranium isotope separation.

Depleted uranium is used for radiation shielding in industrial radiography containers, and for ballast in the keels of ships or in the noses of aircraft.

It is proposed that depleted uranium (in metallic form, but not finely dispersed metallic form) shall be exempt from the requirements of sections 12, 13, 14 and 15 of the Act (possession, use, transport by road, and transport otherwise than by road), if—

(i) the source is being used as radiation shielding in a container for radioactive substances, or as ballast in aircraft or ships; and

(ii) the source is completely contained (encased) within a metallic sheath.

Sealed Radioactive Substances used for Teaching Purposes

For the legislation, a **"sealed radioactive substance"** means a radioactive substance sealed in a way that—

(a) minimises the possibility of its escape or dispersion; and

(b) allows the emission or transmission of ionising radiation.

Certain sealed radioactive substances are used in teaching facilities such as schools, colleges or universities, for demonstrating the characteristics and properties of radioactive substances. For instance, a Strontium 90 sealed radioactive substance may be used to demonstrate characteristics such as the range of beta radiation particles in air; or Caesium 137 might be used to demonstrate the penetrating ability of gamma radiation through various media; or the use of lead sheets as shielding material for gamma rays.

It is proposed that a sealed radioactive substance shall be exempt from the requirements of section 13 of the Act (use), if—

(i) the source is to be used exclusively for demonstration purposes in a teaching facility; and

(ii) the activity of the radionuclide in the sealed source does not exceed the levels stated below, for the relevant sealed source.

Source	**Activity (kBq)**
Cobalt 60	200
Strontium 90	80
Caesium 137	200
Radium 226	20
Americium 241	20

Ores Containing Radionuclides

It is proposed that mineral ores in their natural state (ie. which have not been processed) containing radionuclides that are used as samples for teaching or demonstration purposes shall be exempt from the requirements of sections 12, 13 and 26 of the Act (possession, use, and disposal of a radioactive material), provided that the radiation emitted from the ore or rock sample is less than or equal to 1 microgray per hour at 10 centimetres from the surface of the ore or rock sample.

Abrasive Blasting Material Containing Radionuclides

Abrasive blasting refers to a system which uses a stream of abrasive blasting material propelled at high speed by compressed air, water, steam, centrifugal wheels or paddles, against a surface to clean, abrade, etch or otherwise change the original appearance or condition of the surface.

Abrasive blasting material is any material, including metal shot or metal grit, used or intended to be used for abrasive blasting.

It is proposed that abrasive blasting material containing radionuclides shall be exempt from sections 12, 13 and 26 of the Act (possession, use and disposal of a radioactive material) if—

(a) the sum of the effective dose from external exposure and committed effective dose from intakes (inhalation and ingestion)

as result of abrasive blasting is less than or equal to 0.5 mSv per annum; and

(b) For disposal, the gross alpha and gross beta activity concentrations in the TCLP extracts from the material are no more than 10 times the concentrations specified in the *Australian Drinking Water Guidelines* of the National Health and Medical Research Council and the Agriculture and Resource Management Council of Australia and New Zealand (issued in 1996), for the screening of gross alpha and gross beta activity concentrations, respectively. The extraction fluids used in the test are to be acetate buffer at pH 4.9 and de-ionized water; and

(Where "TCLP" means the toxicity characteristics leaching procedure stated in Australian Standard AS4439.2–1997 *Preparation of Leachates—Zero Head—Space Procedure*.)

(c) The use of the abrasive blasting material for abrasive blasting complies with the *Abrasive Blasting Industry Code of Practice 1999* (issued by the Queensland Department of Employment, Training and Industrial Relations).

Where the abrasive blasting material principally consists of thorium series radionuclides or uranium series radionuclides, the following methodology may be used to demonstrate compliance with (a) above:

The material must comply with the following release criteria:

$$0.7\ (U+D)\ Bq/g \quad + \quad 1.0\ (Th + D)\ Bq/g \quad \leq 1$$

Where (U+D) is the activity concentration in Becquerels per gram of the uranium series radionuclides present in the abrasive material and (Th+D) is the activity concentration in Becquerels per gram of the thorium series radionuclides present in the abrasive material.

"U + D" means uranium series that is uranium plus its progeny (or daughter products).

"T + D" means thorium series that is thorium plus its progeny (or daughter products).

The reader may find it useful to refer to Appendix 5 for technical details about the way in which this methodology has been derived.

Repeal of Part 14 of the *Health Regulation 1996*

Part 14 of the *Health Regulation 1996* currently makes provision for the supply, sale, use or otherwise dealing with abrasive blasting material.

As a consequence of the making of exemptions for abrasive blasting material under the *Radiation Safety Regulation 1999*, Part 14 of the *Health Regulation 1996* will be repealed.

REGISTERS

For the purposes of the legislation, the chief executive of Queensland Health is required to keep a register about licensees, accredited persons, qualified persons (ie. those persons who hold a radiation safety officer certificate), inspectors and State radiation analysts. Each register must contain information that has been prescribed under a regulation.

The register will be open for inspection, free of charge, by members of the public during office hours. A person will be able to take extracts from the register, also free of charge, or obtain a copy of the register (or part of it) on payment of a fee prescribed under a regulation.

It is proposed that the following information be included in the registers to be kept and, as such be available to the general public.

Licensees

- Name of the licensee
- Licence number
- Licence expiry date
- Licence conditions
- Licence type — possession, use, transport (by road or otherwise than by road)
- If the licence is a possession or use licence, the radiation practice to which the licence relates (eg. diagnostic radiography; industrial gauging)
- If the licence is a transport licence (for transport otherwise than by road) for a radioactive substance, the method by which the radioactive substance is to be transported.

Accredited persons

- Name of the accredited person
- Accreditation certificate number
- Accreditation certificate expiry date
- Accreditation certificate conditions

- Type of radiation source or premises for which the accredited person may issue a certificate

Qualified persons (ie. persons who hold a radiation safety officer certificate)

- Name of the qualified person
- Radiation safety officer certificate number
- Radiation safety officer certificate expiry date
- Radiation safety officer certificate conditions
- The radiation practice for which the qualified person may perform the functions of a radiation safety officer

Inspectors

- Name of the inspector
- Inspector's term of appointment
- Conditions of the inspector's appointment

State radiation analysts

- Name of the State radiation analyst
- Analyst's term of appointment
- Conditions of the State radiation analyst's appointment

FEES

Under the *Radiation Safety Act 1999*, fees may be charged for such things as applications (eg. for licences and approvals; for renewals; to change a condition of a licence; renewal of a licence), replacement of an Act instrument (if say a certificate or licence has been lost, stolen, destroyed or damaged), or obtaining a copy of part of a register.

An Act instrument means a licence, an accreditation certificate, an approval, or a radiation safety officer certificate.

A conditional Act instrument means a licence, an accreditation certificate, a continuing approval to acquire, or a radiation safety officer certificate. A continuing approval to acquire may be issued for the periodic acquisition of an unsealed radioactive substance.

The current system of licensing and registration is operating well below cost recovery. This is due to a number of factors, for example:

- currently, the same application fee is charged for possession and use licences, despite the fact that it is significantly more complex (and therefore more costly) to assess an application for a possession licence;
- the holders of composite licences (eg. one licence covering possession, use and transport) are charged only a single fee; and
- certificates of registration relating to the safety status of a number of specific items of irradiating apparatus are issued on the basis of one certificate per licensee, rather than one certificate per item of equipment.

Fees charged under the existing *Radioactive Substances Regulation 1961* have not been reviewed for many years. A new fee structure is planned under the proposed regulation, and it is envisaged that this fee structure will permit greater cost recovery, while at the same time instituting a more equitable system of charging under the legislation.

It is proposed to make a regulation setting the fees to be charged under the Act as follows. It should be noted that the fees for possession licences will be charged for each radiation practice. Examples of how the fees are to apply are given in Appendix 6.

Possession Licence for Radioactive Substance

- *Initial application*

  The initial application fee for a possession licence will be charged for each radiation practice to be carried out with a radioactive substance. Illustrations of how this will work in practice can be found in the examples given in Appendix 6.

  The initial application for a possession licence to be issued for one year will be $220.00 plus $10.00 for each item of sealed radioactive substance and for each type of unsealed radioactive substance, in the possession of the possession licensee.

  The initial application for a possession licence to be issued for two years will be $340.00 plus $10.00 for each item of sealed radioactive substance and for each type of unsealed radioactive substance, in the possession of the possession licensee.

  The initial application for a possession licence to be issued for three years will be $460.00 plus $10.00 for each item of sealed radioactive substance and for each type of unsealed radioactive substance, in the possession of the possession licensee.

  In the event that a person's application is unsuccessful, a portion of the fee (ie. $100.00) will be retained to cover the administration and technical assessment costs associated with processing the application. The remainder of the fee will be refunded.

- *Renewal (per annum)*

  $120.00 plus $10.00 for each item of sealed radioactive substance and for each type of unsealed radioactive substance, in the possession of the possession licensee.

Possession Licence for Ionising Radiation Apparatus

- *Initial application*

  The initial application fee for a possession licence will be charged for each radiation practice to be carried out with an ionising radiation apparatus.

  The initial application for a possession licence to be issued for one year will be $220.00 plus $20.00 for each ionising radiation apparatus in the possession of the possession licensee.

The initial application for a possession licence to be issued for two years will be $340.00 plus $20.00 for each ionising radiation apparatus in the possession of the possession licensee.

The initial application for a possession licence to be issued for three years will be $460.00 plus $20.00 for each ionising radiation apparatus in the possession of the possession licensee.

As previously stated, in the event that a person's application is unsuccessful, $100.00 will be retained to cover the administration and technical assessment costs associated with processing the application. The remainder of the fee will be refunded.

- *Renewal (per annum)*

  $120.00 plus $20.00 for each ionising radiation apparatus in the possession of the possession licensee.

Possession Licence for Non-ionising Radiation Apparatus

- *Initial application*

  The initial application fee for a possession licence will be charged for each radiation practice to be carried out with a non-ionising radiation apparatus.

  The initial application for a possession licence to be issued for one year will be $220.00 plus $10.00 for each non-ionising radiation apparatus in the possession of the possession licensee.

  The initial application for a possession licence to be issued for two years will be $340.00 plus $10.00 for each non-ionising radiation apparatus in the possession of the possession licensee.

  The initial application for a possession licence to be issued for three years will be $460.00 plus $10.00 for each non-ionising radiation apparatus in the possession of the possession licensee.

  Where a person's application is unsuccessful, $100.00 will be retained to cover the administration and technical assessment costs associated with processing the application. The remainder of the fee will be refunded.

- *Renewal (per annum)*

  $120.00 plus $10.00 for each ionising radiation apparatus in the possession of the possession licensee.

Use Licence

- *Initial application*

  The initial application fee for a use licence for one year will be $85.00.

  The initial application fee for a use licence for two years will be $120.00.

  The initial application fee for a use licence for three years will be $155.00.

  In the event that a person's application is unsuccessful, $50.00 will be retained to cover the administration and technical assessment costs associated with processing the application. The remainder of the fee will be refunded.

- *Renewal (per annum)*

  The fee for renewal of a use licence will be $35.00 per annum.

Transport Licence

- *Initial application*

  The initial application fee for a transport licence for one year will be $85.00.

  The initial application fee for a transport licence for two years will be $120.00.

  The initial application fee for a transport licence for three years will be $155.00.

  In the event that a person's application is unsuccessful, $50.00 will be retained to cover the administration and technical assessment costs associated with processing the application. The remainder of the fee will be refunded.

- *Renewal (per annum)*

  The fee for renewal of a use licence will be $35.00 per annum.

Existing Licensees

Please note that for those persons who hold an existing possession, use or transport (by road) licence under the *Radioactive Substances Act 1958*, the initial application fee will be waived. Therefore, the applicable fee for those persons will be that stated for renewal of the particular licence.

Approval to Acquire a Radiation Source

There will be no fee charged for this approval.

Approval to Relocate a Radiation Source

There will be no fee charged for this approval.

Approval to Dispose of a Radiation Source

The fee for an approval to dispose of a radiation source will be $50.00.

Accreditation Certificate

- **Initial application**

  The initial application fee for an accreditation certificate will be charged for each type of radiation source and each type of premises for which a person wishes to be authorised to issue certificates of compliance.

  The initial application fee for an accreditation certificate for one year will be $150.00.

  The initial application fee for an accreditation certificate for two years will be $200.00.

  The initial application fee for an accreditation certificate for three years will be $250.00.

  Where a person's application is unsuccessful, $100.00 will be retained to cover the administration and technical assessment costs associated with processing the application. The remainder of the fee will be refunded.

- *Renewal (per annum)*

  The fee for renewal of an accreditation certificate will be $50.00.

Radiation Safety Officer Certificate

- *Initial application*

  The initial application fee for a radiation safety officer certificate for one year will be $70.00.

  The initial application fee for a radiation safety officer certificate for two years will be $105.00.

  The initial application fee for a radiation safety officer certificate for three years will be $140.00.

  Where a person's application is unsuccessful, $35.00 will be retained to cover the administration and technical assessment costs associated with processing the application. The remainder of the fee will be refunded.

- *Renewal (per annum)*

  The fee for renewal of an radiation safety officer certificate will be $35.00.

Change the Condition of a Conditional Act Instrument

Please note that changing the condition of a conditional Act instrument refers only to changing a condition associated with the radiation safety aspects of the Act instrument. It does not mean changing a standard condition of an Act instrument.

The fee to change the condition of a conditional Act instrument will be $100.00.

Change an Approved Radiation Safety and Protection Plan

The fee to make a change to an approved radiation safety and protection plan will be $50.00.

Replacement of an Act Instrument

The fee for replacement of an Act instrument will be $10.00.

Fee for a copy of a register, or part of a register

The chief executive will keep a register about licensees, accredited persons, qualified persons (ie. those persons who hold a radiation safety officer certificate), inspectors and State radiation analysts.

Copies of the register, or a part of it, may be obtained on payment of a fee of $0.50 per page copied.

Note: The register will be open for inspection, free of charge, by members of the public during office hours. A person will be able to take extracts from the register (ie. by making notes or transcribing information), also free of charge.

MISCELLANEOUS

There are a number of miscellaneous matters that must also be addressed in the proposed regulation. These are addressed below.

Provision of Information

Section 209 of the *Radiation Safety Act 1999* imposes restrictions on the disclosure of information that has been obtained in the course of, or because of, a person's involvement with the administration of the Act.

Information that is protected under this provision includes:

(a) information that would be likely to damage the commercial activities of the person to whom the information relates

(b) information that would adversely affect the intellectual property rights of the person to whom the information relates;

(c) information about a person's health that identifies, or is likely to identify, the person; or

(d) information contained in a personal monitoring record that identifies, or is likely to identify, the person to whom the record relates.

However, there are certain circumstances where it is appropriate or in the public interest to allow such information to be disclosed. Accordingly the Act provides for protected information to be disclosed under the following circumstances, that is if:

(a) the person to whom the information relates gives their written consent;

(b) the information is to be provided to the person to whom the information relates;

(c) the information is otherwise publicly available;

(d) the information is disclosed in the performance of a person's functions under the Act;

(e) the information is to be provided to another government entity for a purpose prescribed under a regulation; or

(f) the disclosure is authorised or permitted under an Act or is required by law.

It is therefore proposed that the regulation make provision for the following bodies to have access to information regarding the type and quantity of radioactive substances stored throughout the State, in accordance with their functions to prevent, and respond to, an emergency situation:

- Queensland Fire and Rescue Authority
- The Chemical Hazards Unit of the Department of Emergency Services.

The information provided to these government entities may be used:

(i) in the development of a plan, or to cause a plan to be developed, to deal with emergency situations which will enable action to be taken to avoid or limit the impact of an emergency situation on persons, property and the environment; and

(ii) ensure that those persons who are called upon to deal with an emergency situation are aware of the hazards, or likely hazards, that they face when bringing a fire or other incident under control.

Where information is provided to another government entity, that entity must not give it to anyone else and must ensure that the information is used only for the purpose for which it was given.

Matters related to an Application for an Act Instrument

The *Radiation Safety Act 1999* states that an application for a licence, an accreditation certificate, an approval or a radiation safety officer certificate must—

(a) be made to the chief executive; and

(b) be in the approved form; and

(c) be accompanied by:

(i) the fee prescribed under a regulation; and

(ii) if the application is for a possession licence—the proposed radiation safety and protection plan for the radiation practice for which the applicant wants to possess a radiation source; and

(iii) if the application is for an approval to relocate—the written approval for the proposed relocation given by the regulatory authority responsible for preventing or minimising health

risks to any person, in so far as exposure to radiation is concerned, in the locality to which the applicant proposes to relocate the radiation source concerned; and

(iv) other documents prescribed under a regulation.

It is proposed that a regulation be made to specify that an application for an approval to relocate must be accompanied by a copy of letter of acceptance of the radiation source by the interstate or international radiation authority for the location to which the radiation source is proposed to be relocated.

Notification of Change in Circumstances

Under the *Radiation Safety Act 1999*, the holder of certain Act instruments is required to give the chief executive written notice of a change in the holder's circumstances, as prescribed under a regulation. This written notice must be provided within 14 days after the happening of the change in circumstances, and must be accompanied by the holder's Act instrument.

The following Act instruments are those to which this requirement applies:

(a) a licence;

(b) an accreditation certificate;

(c) a continuing approval to acquire;

(d) a radiation safety officer certificate.

It is proposed to make a regulation stating that the chief executive must be notified of changes in the following circumstances:

For a Licence

- Licensee's name;
- For a use licence, the licensee's professional registration status;
- Where any other approval or authority that was taken into consideration for the granting of the licence is later repealed suspended or cancelled.

For an Accreditation Certificate

- Certificate holder's name;
- Certificate holder's professional registration status.

For a Continuing Approval to Acquire

- Approval holder's name.

For a Radiation Safety Officer Certificate

- Certificate holder's name.

SCHEDULE 1—RADIOACTIVE SUBSTANCES

Activity concentrations and activities of radionuclides

Part 1—For a radionuclide marked [a] in this Part, parent nuclides and their progeny included in secular equilibrium are listed in Part 2.

Item	Column 1 Radionuclide	Atomic No.	Column 2 Activity concentration (Bq/g)	Column 3 Activity (Bq)
1	Hydrogen-3	1	$1 \times 10^{+6}$	$100 \times 10^{+6}$
2	Beryllium-7	4	$1 \times 10^{+3}$	$1 \times 10^{+7}$
3	Carbon-11	6	$1 \times 10^{+1}$	$1 \times 10^{+6}$
4	Carbon-14	6	$1 \times 10^{+4}$	$1 \times 10^{+7}$
5	Oxygen-15	7	$1 \times 10^{+2}$	$1 \times 10^{+9}$
6	Nitrogen-13	8	$1 \times 10^{+2}$	$1 \times 10^{+9}$
7	Fluoring-18	9	$1 \times 10^{+1}$	$1 \times 10^{+6}$
8	Sodium-22	11	$1 \times 10^{+1}$	$1 \times 10^{+6}$
9	Sodium-24	11	$1 \times 10^{+1}$	$1 \times 10^{+5}$
10	Magnesium-28	12	$1 \times 10^{+1}$	$1 \times 10^{+5}$
11	Silicon-31	14	$1 \times 10^{+3}$	$1 \times 10^{+6}$
12	Phosphorus-32	15	$1 \times 10^{+3}$	$1 \times 10^{+5}$
13	Phosphorus-33	15	$1 \times 10^{+5}$	$1 \times 10^{+8}$
14	Sulphur-35	16	$1 \times 10^{+5}$	$10 \times 10^{+6}$
15	Chlorine-36	17	$1 \times 10^{+4}$	$1 \times 10^{+6}$
16	Chlorine-38	17	$1 \times 10^{+1}$	$1 \times 10^{+5}$
17	Argon-37	18	$1 \times 10^{+6}$	$1 \times 10^{+8}$
18	Argon-41	18	$1 \times 10^{+2}$	$1 \times 10^{+9}$
19	Potassium-40	19	$1 \times 10^{+2}$	$1 \times 10^{+6}$
20	Potassium-42	19	$1 \times 10^{+2}$	$1 \times 10^{+6}$
21	Potassium-43	19	$1 \times 10^{+1}$	$1 \times 10^{+6}$
22	Calcium-45	20	$1 \times 10^{+4}$	$1 \times 10^{+7}$
23	Calcium-47	20	$1 \times 10^{+1}$	$1 \times 10^{+6}$
24	Scandium-46	21	$1 \times 10^{+1}$	$1 \times 10^{+6}$
25	Scandium-47	21	$1 \times 10^{+2}$	$1 \times 10^{+6}$
26	Scandium-48	21	$1 \times 10^{+1}$	$1 \times 10^{+5}$
27	Vanadium-48	23	$1 \times 10^{+1}$	$1 \times 10^{+5}$
28	Chromium-51	24	$1 \times 10^{+3}$	$1 \times 10^{+7}$
29	Manganese-51	25	$1 \times 10^{+1}$	$1 \times 10^{+5}$
30	Manganese-52m	25	$1 \times 10^{+1}$	$1 \times 10^{+5}$
31	Manganese-52	25	$1 \times 10^{+1}$	$1 \times 10^{+5}$

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Column 1 Radionuclide	Atomic No.	Column 2 Activity concentration (Bq/g)	Column 3 Activity (Bq)
32	Manganese-53	25	$1 \times 10^{+4}$	$1 \times 10^{+9}$
33	Manganese-54	25	$1 \times 10^{+1}$	$1 \times 10^{+6}$
34	Manganese-56	25	$1 \times 10^{+1}$	$1 \times 10^{+5}$
35	Iron-52	26	$1 \times 10^{+1}$	$1 \times 10^{+6}$
36	Iron-55	26	$1 \times 10^{+4}$	$1 \times 10^{+6}$
37	Iron-59	26	$1 \times 10^{+1}$	$1 \times 10^{+6}$
38	Cobalt-55	27	$1 \times 10^{+1}$	$1 \times 10^{+6}$
39	Cobalt-56	27	$1 \times 10^{+1}$	$1 \times 10^{+5}$
40	Cobalt-57	27	$1 \times 10^{+2}$	$1 \times 10^{+6}$
41	Cobalt-58	27	$1 \times 10^{+1}$	$1 \times 10^{+6}$
42	Cobalt-58m	27	$1 \times 10^{+4}$	$1 \times 10^{+7}$
43	Cobalt-60m	27	$1 \times 10^{+3}$	$1 \times 10^{+6}$
44	Cobalt-60	27	$1 \times 10^{+1}$	$1 \times 10^{+5}$
45	Cobalt-61	27	$1 \times 10^{+2}$	$1 \times 10^{+6}$
46	Cobalt-62m	27	$1 \times 10^{+1}$	$1 \times 10^{+5}$
47	Nickel-59	28	$1 \times 10^{+4}$	$1 \times 10^{+8}$
48	Nickel-63	28	$1 \times 10^{+5}$	$1 \times 10^{+8}$
49	Nickel-65	28	$1 \times 10^{+1}$	$1 \times 10^{+6}$
50	Copper-64	29	$1 \times 10^{+2}$	$1 \times 10^{+6}$
51	Copper-67	29	$1 \times 10^{+2}$	$1 \times 10^{+6}$
52	Zinc-65	30	$1 \times 10^{+1}$	$1 \times 10^{+6}$
53	Zinc-69m	30	$1 \times 10^{+2}$	$1 \times 10^{+6}$
54	Zinc-69	30	$1 \times 10^{+4}$	$1 \times 10^{+6}$
55	Gallium-67	31	$1 \times 10^{+2}$	$1 \times 10^{+6}$
56	Gallium-72	31	$1 \times 10^{+1}$	$1 \times 10^{+5}$
57	Germanium-68	32	$1 \times 10^{+1}$	$1 \times 10^{+5}$
58	Germanium-71	32	$1 \times 10^{+4}$	$1 \times 10^{+8}$
59	Arsenic-73	33	$1 \times 10^{+3}$	$1 \times 10^{+7}$
60	Arsenic-74	33	$1 \times 10^{+1}$	$1 \times 10^{+6}$
61	Arsenic-76	33	$1 \times 10^{+2}$	$1 \times 10^{+5}$
62	Arsenic-77	33	$1 \times 10^{+3}$	$1 \times 10^{+6}$
63	Selenium-73	34	$1 \times 10^{+1}$	$1 \times 10^{+6}$
64	Selenium-75	34	$1 \times 10^{+2}$	$1 \times 10^{+6}$
65	Bromine-75	35	$1 \times 10^{+1}$	$1 \times 10^{+6}$
66	Bromine-76	35	$1 \times 10^{+1}$	$1 \times 10^{+5}$
67	Bromine-82	35	$1 \times 10^{+1}$	$1 \times 10^{+6}$
68	Krypton-74	36	$1 \times 10^{+2}$	$1 \times 10^{+9}$

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Column 1 Radionuclide	Atomic No.	Column 2 Activity concentration (Bq/g)	Column 3 Activity (Bq)
69	Krypton-76	36	$1 \times 10^{+2}$	$1 \times 10^{+9}$
70	Krypton-77	36	$1 \times 10^{+2}$	$1 \times 10^{+9}$
71	Krypton-79	36	$1 \times 10^{+3}$	$1 \times 10^{+5}$
72	Krypton-81	36	$1 \times 10^{+4}$	$1 \times 10^{+7}$
73	Krypton-83m	36	$1 \times 10^{+5}$	$1 \times 10^{+1+2}$
74	Krypton-85m	36	$1 \times 10^{+5}$	$1 \times 10^{+4}$
75	Krypton-85	36	$1 \times 10^{+3}$	$1 \times 10^{++10}$
76	Krypton-87	36	$1 \times 10^{+2}$	$1 \times 10^{+9}$
77	Krypton-88	36	$1 \times 10^{+2}$	$1 \times 10^{+9}$
78	Rubidium-81	37	$1 \times 10^{+1}$	$1 \times 10^{+6}$
79	Rubidium-86	37	$1 \times 10^{+2}$	$1 \times 10^{+5}$
80	Strontium-85m	38	$1 \times 10^{+2}$	$1 \times 10^{+7}$
81	Strontium-85	38	$1 \times 10^{+2}$	$1 \times 10^{+6}$
82	Strontium-87m	38	$1 \times 10^{+2}$	$1 \times 10^{+6}$
83	Strontium-89	38	$1 \times 10^{+3}$	$1 \times 10^{+5}$
84	Strontium-90	38	$1 \times 10^{+2}$	$1 \times 10^{+4}$
85	Strontium-91	38	$1 \times 10^{+1}$	$1 \times 10^{+5}$
86	Strontium-92	38	$1 \times 10^{+1}$	$1 \times 10^{+6}$
87	Yttrium-90	39	$1 \times 10^{+3}$	$1 \times 10^{+5}$
88	Yttrium-91m	39	$1 \times 10^{+2}$	$1 \times 10^{+6}$
89	Yttrium-91	39	$1 \times 10^{+3}$	$1 \times 10^{+6}$
90	Yttrium-92	39	$1 \times 10^{+2}$	$1 \times 10^{+5}$
91	Yttrium-93	39	$1 \times 10^{+2}$	$1 \times 10^{+5}$
92	Zirconium-93[a]	40	$1 \times 10^{+3}$	$1 \times 10^{+7}$
93	Zirconium-95	40	$1 \times 10^{+1}$	$1 \times 10^{+6}$
94	Zirconium-97[a]	40	$1 \times 10^{+1}$	$1 \times 10^{+5}$
95	Niobium-93m	41	$1 \times 10^{+4}$	$1 \times 10^{+7}$
96	Niobium-94	41	$1 \times 10^{+1}$	$1 \times 10^{+6}$
97	Niobium-95	41	$1 \times 10^{+1}$	$1 \times 10^{+6}$
98	Niobium-97	41	$1 \times 10^{+1}$	$1 \times 10^{+6}$
99	Niobium-98	41	$1 \times 10^{+1}$	$1 \times 10^{+5}$
100	Molybdenum-90	42	$1 \times 10^{+1}$	$1 \times 10^{+6}$
101	Molybdenum-93	42	$1 \times 10^{+3}$	$1 \times 10^{+8}$
102	Molybdenum-99[a]	42	$1 \times 10^{+2}$	$1 \times 10^{+6}$
103	Molybdenum-101	42	$1 \times 10^{+1}$	$1 \times 10^{+6}$
104	Technetium-95m	43	$1 \times 10^{+1}$	$1 \times 10^{+6}$
105	Technetium-96m	43	$1 \times 10^{+1}$	$1 \times 10^{+6}$

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Column 1 Radionuclide	Atomic No.	Column 2 Activity concentration (Bq/g)	Column 3 Activity (Bq)
106	Technetium-96	43	$1 \times 10^{+3}$	$1 \times 10^{+7}$
107	Technetium-97m	43	$1 \times 10^{+3}$	$1 \times 10^{+7}$
108	Technetium-97	43	$1 \times 10^{+3}$	$1 \times 10^{+8}$
109	Technetium-99m	43	$1 \times 10^{+2}$	$1 \times 10^{+7}$
110	Technetium-99	43	$1 \times 10^{+4}$	$1 \times 10^{+7}$
111	Ruthenium-97	44	$1 \times 10^{+2}$	$1 \times 10^{+7}$
112	Ruthenium-103	44	$1 \times 10^{+2}$	$1 \times 10^{+6}$
113	Ruthenium-105	44	$1 \times 10^{+1}$	$1 \times 10^{+6}$
114	Ruthenium-106[a]	44	$1 \times 10^{+2}$	$1 \times 10^{+5}$
115	Rhodium-103m	45	$1 \times 10^{+4}$	$1 \times 10^{+8}$
116	Rhodium-105	45	$1 \times 10^{+2}$	$1 \times 10^{+7}$
117	Palladium-103	46	$1 \times 10^{+3}$	$1 \times 10^{+8}$
118	Palladium-109	46	$1 \times 10^{+3}$	$1 \times 10^{+6}$
119	Silver-105	47	$1 \times 10^{+2}$	$1 \times 10^{+6}$
120	Silver-110m	47	$1 \times 10^{+1}$	$1 \times 10^{+6}$
121	Silver-111	47	$1 \times 10^{+3}$	$1 \times 10^{+6}$
122	Cadmium-109	48	$1 \times 10^{+4}$	$1 \times 10^{+6}$
123	Cadmium-115m	48	$1 \times 10^{+3}$	$1 \times 10^{+6}$
124	Cadmium-115	48	$1 \times 10^{+2}$	$1 \times 10^{+6}$
125	Indium-111	49	$1 \times 10^{+2}$	$1 \times 10^{+6}$
126	Indium-113m	49	$1 \times 10^{+2}$	$1 \times 10^{+6}$
127	Indium-114m	49	$1 \times 10^{+2}$	$1 \times 10^{+6}$
128	Indium-115m	49	$1 \times 10^{+2}$	$1 \times 10^{+6}$
129	Tin-113	50	$1 \times 10^{+3}$	$1 \times 10^{+7}$
130	Tin-117m	50	$1 \times 10^{+2}$	$1 \times 10^{+6}$
131	Tin-121	50	$1 \times 10^{+5}$	$1 \times 10^{+7}$
132	Tin-125	50	$1 \times 10^{+2}$	$1 \times 10^{+5}$
133	Antimony-122	51	$1 \times 10^{+2}$	$1 \times 10^{+4}$
134	Antimony-124	51	$1 \times 10^{+1}$	$1 \times 10^{+6}$
135	Antimony-125	51	$1 \times 10^{+2}$	$1 \times 10^{+6}$
136	Tellurium-123m	52	$1 \times 10^{+2}$	$1 \times 10^{+7}$
137	Tellurium-125m	52	$1 \times 10^{+3}$	$1 \times 10^{+7}$
138	Tellurium-127m	52	$1 \times 10^{+3}$	$1 \times 10^{+7}$
139	Tellurium-127	52	$1 \times 10^{+3}$	$1 \times 10^{+6}$
140	Tellurium-129m	52	$1 \times 10^{+3}$	$1 \times 10^{+6}$
141	Tellurium-129	52	$1 \times 10^{+2}$	$1 \times 10^{+6}$
142	Tellurium-131m	52	$1 \times 10^{+1}$	$1 \times 10^{+6}$

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Column 1 Radionuclide	Atomic No.	Column 2 Activity concentration (Bq/g)	Column 3 Activity (Bq)
143	Tellurium-131	52	$1 \times 10^{+2}$	$1 \times 10^{+5}$
144	Tellurium-132	52	$1 \times 10^{+2}$	$1 \times 10^{+7}$
145	Tellurium-133m	52	$1 \times 10^{+1}$	$1 \times 10^{+5}$
146	Tellurium-133	52	$1 \times 10^{+1}$	$1 \times 10^{+5}$
147	Tellurium-134	52	$1 \times 10^{+1}$	$1 \times 10^{+6}$
148	Iodine-123	53	$1 \times 10^{+2}$	$1 \times 10^{+7}$
149	Iodine-124	53	$1 \times 10^{+1}$	$1 \times 10^{+6}$
150	Iodine-125	53	$1 \times 10^{+3}$	$1 \times 10^{+6}$
151	Iodine-126	53	$1 \times 10^{+2}$	$1 \times 10^{+6}$
152	Iodine-129	53	$1 \times 10^{+2}$	$1 \times 10^{+5}$
153	Iodine-130	53	$1 \times 10^{+1}$	$1 \times 10^{+6}$
154	Iodine-131	53	$1 \times 10^{+2}$	$1 \times 10^{+5}$
155	Iodine-132	53	$1 \times 10^{+1}$	$1 \times 10^{+5}$
156	Iodine-133	53	$1 \times 10^{+1}$	$1 \times 10^{+6}$
157	Iodine-134	53	$1 \times 10^{+1}$	$1 \times 10^{+5}$
158	Iodine-135	53	$1 \times 10^{+1}$	$1 \times 10^{+6}$
159	Xenon-131m	54	$1 \times 10^{+4}$	$1 \times 10^{+4}$
160	Xenon-133	54	$1 \times 10^{+3}$	$1 \times 10^{+4}$
161	Xenon-135	54	$1 \times 10^{+3}$	$1 \times 10^{++10}$
162	Caesium-129	55	$1 \times 10^{+2}$	$1 \times 10^{+5}$
163	Caesium-131	55	$1 \times 10^{+3}$	$1 \times 10^{+6}$
164	Caesium-132	55	$1 \times 10^{+1}$	$1 \times 10^{+5}$
165	Caesium-134m	55	$1 \times 10^{+3}$	$1 \times 10^{+5}$
166	Caesium-134	55	$1 \times 10^{+1}$	$1 \times 10^{+4}$
167	Caesium-135	55	$1 \times 10^{+4}$	$1 \times 10^{+7}$
168	Caesium-136	55	$1 \times 10^{+1}$	$1 \times 10^{+5}$
169	Caesium-137[a]	55	$1 \times 10^{+1}$	$1 \times 10^{+4}$
170	Caesium-138	55	$1 \times 10^{+1}$	$1 \times 10^{+4}$
171	Barium-131	56	$1 \times 10^{+2}$	$1 \times 10^{+6}$
172	Barium-133	56	$1 \times 10^{+2}$	$1 \times 10^{+6}$
173	Barium-140[a]	56	$1 \times 10^{+1}$	$1 \times 10^{+5}$
174	Lanthanum-140	57	$1 \times 10^{+1}$	$1 \times 10^{+5}$
175	Cerium-139	58	$1 \times 10^{+2}$	$1 \times 10^{+6}$
176	Cerium-141	58	$1 \times 10^{+2}$	$1 \times 10^{+7}$
177	Cerium-143	58	$1 \times 10^{+2}$	$1 \times 10^{+6}$
178	Cerium-144[a]	58	$1 \times 10^{+2}$	$1 \times 10^{+5}$
179	Praseodymium-142	59	$1 \times 10^{+2}$	$1 \times 10^{+5}$

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Column 1 Radionuclide	Atomic No.	Column 2 Activity concentration (Bq/g)	Column 3 Activity (Bq)
180	Praseodymium-143	59	$1 \times 10^{+4}$	$1 \times 10^{+6}$
181	Neodymium-147	60	$1 \times 10^{+2}$	$1 \times 10^{+6}$
182	Neodymium-149	60	$1 \times 10^{+2}$	$1 \times 10^{+6}$
183	Promethium-147	61	$1 \times 10^{+4}$	$1 \times 10^{+7}$
184	Promethium-149	61	$1 \times 10^{+3}$	$1 \times 10^{+6}$
185	Samarium-147	62	$1 \times 10^{+1}$	$1 \times 10^{+4}$
186	Samarium-151	62	$1 \times 10^{+4}$	$1 \times 10^{+8}$
187	Samarium-153	62	$1 \times 10^{+2}$	$1 \times 10^{+5}$
188	Europium-152m	63	$1 \times 10^{+2}$	$1 \times 10^{+6}$
189	Europium-152	63	$1 \times 10^{+1}$	$1 \times 10^{+6}$
190	Europium-154	63	$1 \times 10^{+1}$	$1 \times 10^{+6}$
191	Europium-155	63	$1 \times 10^{+2}$	$1 \times 10^{+7}$
192	Gadolinium-153	64	$1 \times 10^{+2}$	$1 \times 10^{+7}$
193	Gadolinium-159	64	$1 \times 10^{+3}$	$1 \times 10^{+6}$
194	Terbium-149	65	$1 \times 10^{+1}$	$1 \times 10^{+6}$
195	Terbium-160	65	$1 \times 10^{+1}$	$1 \times 10^{+6}$
196	Dysprosium-165	66	$1 \times 10^{+3}$	$1 \times 10^{+6}$
197	Dysprosium-166	66	$1 \times 10^{+3}$	$1 \times 10^{+6}$
198	Holmium-166	67	$1 \times 10^{+3}$	$1 \times 10^{+5}$
199	Erbium-161	68	$1 \times 10^{+1}$	$1 \times 10^{+6}$
200	Erbium-169	68	$1 \times 10^{+4}$	$1 \times 10^{+7}$
201	Erbium-171	68	$1 \times 10^{+2}$	$1 \times 10^{+6}$
202	Thulium-170	69	$1 \times 10^{+3}$	$1 \times 10^{+6}$
203	Thulium-171	69	$1 \times 10^{+4}$	$1 \times 10^{+8}$
204	Ytterbium-169	70	$1 \times 10^{+2}$	$1 \times 10^{+7}$
205	Ytterbium-175	70	$1 \times 10^{+3}$	$1 \times 10^{+7}$
206	Lutetium-177	71	$1 \times 10^{+3}$	$1 \times 10^{+7}$
207	Hafnium-181	72	$1 \times 10^{+1}$	$1 \times 10^{+6}$
208	Tantalum-182	73	$1 \times 10^{+1}$	$1 \times 10^{+4}$
209	Tungsten-181	74	$1 \times 10^{+3}$	$1 \times 10^{+7}$
210	Tungsten-185	74	$1 \times 10^{+4}$	$1 \times 10^{+7}$
211	Tungsten-187	74	$1 \times 10^{+2}$	$1 \times 10^{+6}$
212	Tungsten-188	74	$1 \times 10^{+2}$	$1 \times 10^{+5}$
213	Rhenium-186	75	$1 \times 10^{+3}$	$1 \times 10^{+6}$
214	Rhenium-188	75	$1 \times 10^{+2}$	$1 \times 10^{+5}$
215	Osmium-185	76	$1 \times 10^{+1}$	$1 \times 10^{+6}$
216	Osmium-191m	76	$1 \times 10^{+3}$	$1 \times 10^{+7}$

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Column 1 Radionuclide	Atomic No.	Column 2 Activity concentration (Bq/g)	Column 3 Activity (Bq)
217	Osmium-191	76	$1 \times 10^{+2}$	$1 \times 10^{+7}$
218	Osmium-193	76	$1 \times 10^{+2}$	$1 \times 10^{+6}$
219	Iridium-190	77	$1 \times 10^{+1}$	$1 \times 10^{+6}$
220	Iridium-192	77	$1 \times 10^{+1}$	$1 \times 10^{+4}$
221	Iridium-194	77	$1 \times 10^{+2}$	$1 \times 10^{+5}$
222	Platinum-191	78	$1 \times 10^{+2}$	$1 \times 10^{+6}$
223	Platinum-193m	78	$1 \times 10^{+3}$	$1 \times 10^{+7}$
224	Platinum-197m	78	$1 \times 10^{+3}$	$1 \times 10^{+6}$
225	Platinum-197	78	$1 \times 10^{+2}$	$1 \times 10^{+6}$
226	Gold-198	79	$1 \times 10^{+2}$	$1 \times 10^{+6}$
227	Gold-199	79	$1 \times 10^{+2}$	$1 \times 10^{+6}$
228	Mercury-195m	80	$1 \times 10^{+2}$	$1 \times 10^{+7}$
229	Mercury-197m	80	$1 \times 10^{+2}$	$1 \times 10^{+6}$
230	Mercury-197	80	$1 \times 10^{+2}$	$1 \times 10^{+6}$
231	Mercury-203	80	$1 \times 10^{+2}$	$1 \times 10^{+5}$
232	Thallium-200	81	$1 \times 10^{+1}$	$1 \times 10^{+6}$
233	Thallium-201	81	$1 \times 10^{+2}$	$1 \times 10^{+6}$
234	Thallium-202	81	$1 \times 10^{+2}$	$1 \times 10^{+6}$
235	Thallium-204	81	$1 \times 10^{+4}$	$1 \times 10^{+4}$
236	Lead-203	82	$1 \times 10^{+2}$	$1 \times 10^{+6}$
237	Lead-210[a]	82	$1 \times 10^{+1}$	$1 \times 10^{+4}$
238	Lead-212[a]	82	$1 \times 10^{+1}$	$1 \times 10^{+5}$
239	Bismuth-206	83	$1 \times 10^{+1}$	$1 \times 10^{+5}$
240	Bismuth-207	83	$1 \times 10^{+1}$	$1 \times 10^{+6}$
241	Bismuth-210	83	$1 \times 10^{+3}$	$1 \times 10^{+6}$
242	Bismuth-212[a]	83	$1 \times 10^{+1}$	$1 \times 10^{+5}$
243	Bismuth-213	83	$1 \times 10^{+2}$	$1 \times 10^{+6}$
244	Polonium-203	84	$1 \times 10^{+1}$	$1 \times 10^{+6}$
245	Polonium-205	84	$1 \times 10^{+1}$	$1 \times 10^{+6}$
246	Polonium-207	84	$1 \times 10^{+1}$	$1 \times 10^{+6}$
247	Polonium-210	84	$1 \times 10^{+1}$	$1 \times 10^{+4}$
248	Astatine-211	85	$1 \times 10^{+3}$	$1 \times 10^{+7}$
249	Radon-220[a]	86	$1 \times 10^{+4}$	$1 \times 10^{+7}$
250	Radon-222[a]	86	$1 \times 10^{+1}$	$1 \times 10^{+8}$
251	Radium-223[a]	88	$1 \times 10^{+2}$	$1 \times 10^{+5}$
252	Radium-224[a]	88	$1 \times 10^{+1}$	$1 \times 10^{+5}$
253	Radium-225	88	$1 \times 10^{+2}$	$1 \times 10^{+5}$

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Column 1 Radionuclide	Atomic No.	Column 2 Activity concentration (Bq/g)	Column 3 Activity (Bq)
254	Radium-226[a]	88	$1 \times 10^{+1}$	$1 \times 10^{+4}$
255	Radium-227	88	$1 \times 10^{+2}$	$1 \times 10^{+6}$
256	Radium-228[a]	88	$1 \times 10^{+1}$	$1 \times 10^{+5}$
257	Actinium-225	89	$1 \times 10^{+1}$	$1 \times 10^{+4}$
258	Actinium-227	89	$1 \times 10^{+1}$	$1 \times 10^{+3}$
259	Actinium-228	89	$1 \times 10^{+1}$	$1 \times 10^{+6}$
260	Thorium-226[a]	90	$1 \times 10^{+3}$	$1 \times 10^{+7}$
261	Thorium-227	90	$1 \times 10^{+1}$	$1 \times 10^{+4}$
262	Thorium-228[a]	90	1×10^{0}	$1 \times 10^{+4}$
263	Thorium-229[a]	90	1×10^{0}	$1 \times 10^{+3}$
264	Thorium-230	90	1×10^{0}	$1 \times 10^{+4}$
265	Thorium-231	90	$1 \times 10^{+3}$	$1 \times 10^{+7}$
266	Thorium-nat[a]	90	1×10^{0}	$1 \times 10^{+3}$
267	Thorium-234	90	$1 \times 10^{+3}$	$1 \times 10^{+5}$
268	Protactinium-230	91	$1 \times 10^{+1}$	$1 \times 10^{+6}$
269	Protactinium-231	91	1×10^{0}	$1 \times 10^{+3}$
270	Protactinium-233	91	$1 \times 10^{+2}$	$1 \times 10^{+7}$
271	Uranium-230[a]	92	$1 \times 10^{+1}$	$1 \times 10^{+5}$
272	Uranium-231	92	$1 \times 10^{+2}$	$1 \times 10^{+7}$
273	Uranium-232[a]	92	1×10^{0}	$1 \times 10^{+3}$
274	Uranium-233	92	$1 \times 10^{+1}$	$1 \times 10^{+4}$
275	Uranium-234	92	$1 \times 10^{+1}$	$1 \times 10^{+4}$
276	Uranium-235[a]	92	$1 \times 10^{+1}$	$1 \times 10^{+4}$
277	Uranium-236	92	$1 \times 10^{+1}$	$1 \times 10^{+4}$
278	Uranium-237	92	$1 \times 10^{+2}$	$1 \times 10^{+6}$
279	Uranium-238[a]	92	$1 \times 10^{+1}$	$1 \times 10^{+4}$
280	Uranium-nat[a]	92	1×10^{0}	$1 \times 10^{+3}$
281	Uranium-239	92	$1 \times 10^{+2}$	$1 \times 10^{+6}$
282	Uranium-240	92	$1 \times 10^{+3}$	$1 \times 10^{+7}$
283	Uranium240[a]	92	$1 \times 10^{+1}$	$1 \times 10^{+6}$
284	Neptunium237[a]	93	1×10^{0}	$1 \times 10^{+3}$
285	Neptunium-239	93	$1 \times 10^{+2}$	$1 \times 10^{+7}$
286	Neptunium-240	93	$1 \times 10^{+1}$	$1 \times 10^{+6}$
287	Plutonium-234	94	$1 \times 10^{+2}$	$1 \times 10^{+7}$
288	Plutonium-235	94	$1 \times 10^{+2}$	$1 \times 10^{+7}$
289	Plutonium-236	94	$1 \times 10^{+1}$	$1 \times 10^{+4}$
290	Plutonium-237	94	$1 \times 10^{+3}$	$1 \times 10^{+7}$

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Column 1 Radionuclide	Atomic No.	Column 2 Activity concentration (Bq/g)	Column 3 Activity (Bq)
291	Plutonium-238	94	1×10^{0}	$1 \times 10^{+4}$
292	Plutonium-239	94	1×10^{0}	$1 \times 10^{+4}$
293	Plutonium-240	94	1×10^{0}	$1 \times 10^{+3}$
294	Plutonium-241	94	$1 \times 10^{+2}$	$1 \times 10^{+5}$
295	Plutonium-242	94	1×10^{0}	$1 \times 10^{+4}$
296	Plutonium-243	94	$1 \times 10^{+3}$	$1 \times 10^{+7}$
297	Plutonium-244	94	1×10^{0}	$1 \times 10^{+4}$
298	Americium-241	95	1×10^{0}	$1 \times 10^{+4}$
299	Americium-242m[a]	95	1×10^{0}	$1 \times 10^{+4}$
300	Americium-242	95	$1 \times 10^{+3}$	$1 \times 10^{+6}$
301	Americium-243[a]	95	1×10^{0}	$1 \times 10^{+3}$
302	Curium-242	96	$1 \times 10^{+2}$	$1 \times 10^{+5}$
303	Curium-243	96	1×10^{0}	$1 \times 10^{+4}$
304	Curium-244	96	$1 \times 10^{+1}$	$1 \times 10^{+4}$
305	Curium-245	96	1×10^{0}	$1 \times 10^{+3}$
306	Curium-246	96	1×10^{0}	$1 \times 10^{+3}$
307	Curium-247	96	1×10^{0}	$1 \times 10^{+4}$
308	Curium-248	96	1×10^{0}	$1 \times 10^{+3}$
309	Berkelium-249	97	$1 \times 10^{+3}$	$1 \times 10^{+6}$
310	Californium-246	98	$1 \times 10^{+3}$	$1 \times 10^{+6}$
311	Californium-248	98	$1 \times 10^{+1}$	$1 \times 10^{+4}$
312	Californium-249	98	1×10^{0}	$1 \times 10^{+3}$
313	Californium-250	98	$1 \times 10^{+1}$	$1 \times 10^{+4}$
314	Californium-251	98	1×10^{0}	$1 \times 10^{+3}$
315	Californium-252	98	$1 \times 10^{+1}$	$1 \times 10^{+4}$
316	Californium-253	98	$1 \times 10^{+2}$	$1 \times 10^{+5}$
317	Californium-254	98	1×10^{0}	$1 \times 10^{+3}$
318	Einsteinium-253	99	$1 \times 10^{+2}$	$1 \times 10^{+5}$
319	Einsteinium-254m	99	$1 \times 10^{+2}$	$1 \times 10^{+6}$
320	Einsteinium-254	99	$1 \times 10^{+1}$	$1 \times 10^{+4}$
321	Fermium-254	100	$1 \times 10^{+4}$	$1 \times 10^{+7}$
322	Fermium-255	100	$1 \times 10^{+3}$	$1 \times 10^{+6}$

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Column 1 Radionuclide	Atomic No.	Column 2 Activity concentration (Bq/g)	Column 3 Activity (Bq)
323	alpha-emitting radionuclide not mentioned in another item		1×10^{0}	$1 \times 10^{+3}$
324	radionuclide that is not alpha-emitting and not mentioned in another item		$1 \times 10^{+1}$	$1 \times 10^{+4}$

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Part 2—Nuclides and progeny

For a nuclide marked [a] in Part 2, parent nuclides and their progeny included in secular equilibrium are listed in the following table:

Item	Parent nuclide	Progeny
1	Strontium-90	Yttrium-90
2	Zirconium-93	Niobium-93m
3	Zirconium-97	Niobium-97
4	Molybdenum-99	Technetium-99m
5	Ruthenium-106	Rhodium-106
6	Caesium-137	Barium-137m
7	Barium-140	Lanthanum-140
8	Cerium-144	Praseodimium-144
9	Lead-210	Bismuth-210 Polonium-210
10	Lead-212	Bismuth-212 Thallium-208 Polonium-212
6	Caesium-137	Barium-137m
7	Cerium-144	Praseodimium-144
8	Barium-140	Lanthanum-140
9	Bismuth-212	Thallium-208 Polonium-212
10	Lead-210	Bismuth-210 Polonium-210
11	Lead-212	Bismuth-212 Thallium-208 Polonium-212
12	Radon-220	Polonium-216
13	Radon-222	Polonium-218 Lead-214 Bismuth-214 Polonium-214
14	Radium-223	Radon-219 Polonium-215 Lead-211 Bismuth-211 Thallium-207

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Parent nuclide	Progeny
15	Radium-224	Radon-220 Polonium-216 Lead-212 Bismuth-212 Thallium-208 Polonium-212
16	Radium-226	Radon-222 Polonium-218 Lead-214 Bismuth-214 Polonium-214 Lead-210 Bismuth-210 Polonium-210
17	Radium-228	Actinium-228
18	Thorium-226	Radium-222 Radon-218 Polonium-214
19	Thorium-228	Radium-224 Radon-220 Polonium-216 Lead-212 Bismuth-212 Thallium-208 Polonium-212
20	Thorium-229	Radium-225 Actinium-225 Francium-221 Astatine-217 Bismuth-213 Polonium-213 Lead-209
21	Thorium-nat	Radium-228 Actinium-228 Thorium-228 Radium-224 Radon-220 Polonium-216

SCHEDULE 1—RADIOACTIVE SUBSTANCES (continued)

Item	Parent nuclide	Progeny
		Lead-212
		Bismuth-212
		Thallium-208
		Polonium-212
22	Thorium234	Protoactinium-234m
23	Uranium-230	Thorium-226
		Radium-222
		Radon-218
		Polonium-214
24	Uranium-232	Thorium-228
		Radium-224
		Radon-220
		Polonium-216
		Lead-212
		Bismuth-212
		Thallium-208
		Polonium-212
25	Uranium-235	Thorium-231
26	Uranium-238	Thorium-234
		Protoactinium-234m
27	Uranium-nat	Thorium-234
		Protoactinium-234m
		Uranium-234
		Thorium-230
		Radium-226
		Radon-222
		Polonium-218
		Lead-214
		Bismuth-214
		Polonium-214
		Lead-210
		Bismuth-210
		Polonium-210
28	Uranium-240	Neptunium-240m
29	Neptunium-237	Protoactinium-233
30	Americium-241	Americium-242
31	Americium-243	Neptunium-239

SCHEDULE 2—DISPOSAL

Maximum permissible activity concentration for radioactive materials to be released into the environment and sewerage system

Item	Radionuclide	Atomic No.	Release to Air Activity Concentration (Bq/m^3)	Release to Water Activity Concentration (Bq/m^3)	Release to Sewerage System Activity Concentration (Bq/m^3)
1	Hydrogen-3	1	$1.65 \times 10^{+7}$	$3.81 \times 10^{+7}$	$7.61 \times 10^{+7}$
2	Beryllium-7	4	$5.73 \times 10^{+2}$	$2.45 \times 10^{+7}$	$4.89 \times 10^{+7}$
3	Carbon-11	6	$9.31 \times 10^{+3}$	$2.85 \times 10^{+7}$	$5.71 \times 10^{+7}$
4	Carbon-14	6	$5.13 \times 10^{+1}$	$1.18 \times 10^{+6}$	$2.36 \times 10^{+6}$
5	Nitrogen-13[1]	7	-	-	-
6	Oxygen-15[1]	8	-	-	-
7	Fluorine-18	9	$3.20 \times 10^{+2}$	$1.4 \times 10^{+7}$	$2.8 \times 10^{+7}$
8	Sodium-22	11	$1.49 \times 10^{+1}$	$2.14 \times 10^{+5}$	$4.28 \times 10^{+5}$
9	Sodium-24	11	$5.62 \times 10^{+1}$	$1.59 \times 10^{+6}$	$3.19 \times 10^{+6}$
10	Magnesium-28	12	$1.75 \times 10^{+1}$	$3.11 \times 10^{+5}$	$6.23 \times 10^{+5}$
11	Silicon-31	14	$2.71 \times 10^{+2}$	$4.28 \times 10^{+6}$	$8.56 \times 10^{+6}$
12	Phosphorus-32	15	9.31×10^{0}	$2.85 \times 10^{+5}$	$5.71 \times 10^{+5}$
13	Phosphorus-33	15	$2.13 \times 10^{+1}$	$2.85 \times 10^{+6}$	$5.71 \times 10^{+6}$
14	Sulphur-35	16	$2.29 \times 10^{+2}$	$8.90 \times 10^{+5}$	$1.78 \times 10^{+6}$
15	Chlorine-36	17	4.32×10^{0}	$7.36 \times 10^{+5}$	$1.47 \times 10^{+6}$
16	Chlorine-38	17	$4.08 \times 10^{+2}$	$5.71 \times 10^{+6}$	$1.14 \times 10^{+7}$
17	Argon-37[2]	18	$3.34 \times 10^{+8}$	-	-
18	Argon-41[2]	18	$2.58 \times 10^{+2}$	-	-
19	Potassium-40	19	9.93×10^{0}	$1.10 \times 10^{+5}$	$2.21 \times 10^{+5}$
20	Potassium-42	19	$1.49 \times 10^{+2}$	$1.59 \times 10^{+6}$	$3.19 \times 10^{+6}$
21	Potassium-43	19	$1.15 \times 10^{+2}$	$2.74 \times 10^{+6}$	$5.48 \times 10^{+6}$
22	Calcium-45	20	$1.10 \times 10^{+1}$	$9.01 \times 10^{+5}$	$1.80 \times 10^{+6}$
23	Calcium-47	20	$1.42 \times 10^{+1}$	$4.28 \times 10^{+5}$	$8.56 \times 10^{+5}$
24	Scandium-46	21	4.65×10^{0}	$4.57 \times 10^{+5}$	$9.13 \times 10^{+5}$
25	Scandium-47	21	$4.08 \times 10^{+1}$	$1.27 \times 10^{+6}$	$2.54 \times 10^{+6}$
26	Scandium-48	21	$1.86 \times 10^{+1}$	$4.03 \times 10^{+5}$	$8.06 \times 10^{+5}$
27	Vanadium-48	23	$1.10 \times 10^{+1}$	$3.42 \times 10^{+5}$	$6.85 \times 10^{+5}$
28	Chromium-51	24	$8.27 \times 10^{+2}$	$1.80 \times 10^{+7}$	$3.60 \times 10^{+7}$
29	Manganese-51	25	$4.38 \times 10^{+2}$	$7.36 \times 10^{+6}$	$1.47 \times 10^{+7}$
30	Manganese-52	25	$1.65 \times 10^{+1}$	$3.81 \times 10^{+5}$	$7.61 \times 10^{+5}$

SCHEDULE 2—DISPOSAL (continued)

Item	Radionuclide	Atomic No.	Release to Air Activity Concentration (Bq/m^3)	Release to Water Activity Concentration (Bq/m^3)	Release to Sewerage System Activity Concentration (Bq/m^3)
31	Manganese-52m	25	$5.96 \times 10^{+2}$	$9.93 \times 10^{+6}$	$1.99 \times 10^{+7}$
32	Manganese-53	25	$5.73 \times 10^{+2}$	$2.28 \times 10^{+7}$	$4.57 \times 10^{+7}$
33	Manganese-54	25	$1.99 \times 10^{+1}$	$9.65 \times 10^{+5}$	$1.93 \times 10^{+6}$
34	Manganese-56	25	$1.49 \times 10^{+2}$	$2.74 \times 10^{+6}$	$5.48 \times 10^{+6}$
35	Iron-52	26	$3.13 \times 10^{+1}$	$4.89 \times 10^{+5}$	$9.78 \times 10^{+5}$
36	Iron-55	26	$3.24 \times 10^{+1}$	$2.08 \times 10^{+6}$	$4.15 \times 10^{+6}$
37	Iron-59	26	8.51×10^{0}	$3.81 \times 10^{+5}$	$7.61 \times 10^{+5}$
38	Cobalt-55	27	$3.59 \times 10^{+1}$	$6.23 \times 10^{+5}$	$1.25 \times 10^{+6}$
39	Cobalt-56	27	4.73×10^{0}	$2.74 \times 10^{+5}$	$5.48 \times 10^{+5}$
40	Cobalt-57	27	$3.17 \times 10^{+1}$	$3.26 \times 10^{+6}$	$6.52 \times 10^{+6}$
41	Cobalt-58m	27	$1.75 \times 10^{+3}$	$2.85 \times 10^{+7}$	$5.71 \times 10^{+7}$
42	Cobalt-58	27	$1.49 \times 10^{+1}$	$9.26 \times 10^{+5}$	$1.85 \times 10^{+6}$
43	Cobalt-60m	27	$2.29 \times 10^{+4}$	$4.03 \times 10^{+8}$	$8.06 \times 10^{+8}$
44	Cobalt-60	27	1.03×10^{0}	$2.01 \times 10^{+5}$	$4.03 \times 10^{+5}$
45	Cobalt-61	27	$3.97 \times 10^{+2}$	$9.26 \times 10^{+6}$	$1.85 \times 10^{+7}$
46	Cobalt-62m	27	$8.05 \times 10^{+2}$	$1.46 \times 10^{+7}$	$2.91 \times 10^{+7}$
47	Nickel-59	28	$1.35 \times 10^{+2}$	$1.09 \times 10^{+7}$	$2.17 \times 10^{+7}$
48	Nickel-63	28	$5.73 \times 10^{+1}$	$4.57 \times 10^{+6}$	$9.13 \times 10^{+6}$
49	Nickel-65	28	$2.29 \times 10^{+2}$	$3.81 \times 10^{+6}$	$7.61 \times 10^{+6}$
50	Copper-64	29	$1.99 \times 10^{+2}$	$5.71 \times 10^{+6}$	$1.14 \times 10^{+7}$
51	Copper-67	29	$5.13 \times 10^{+1}$	$2.01 \times 10^{+6}$	$4.03 \times 10^{+6}$
52	Zinc-65	30	$1.03 \times 10^{+1}$	$1.76 \times 10^{+5}$	$3.51 \times 10^{+5}$
53	Zinc-69m	30	$9.02 \times 10^{+1}$	$2.08 \times 10^{+6}$	$4.15 \times 10^{+6}$
54	Zinc-69	30	$6.93 \times 10^{+2}$	$2.21 \times 10^{+7}$	$4.42 \times 10^{+7}$
55	Gallium-67	31	$1.06 \times 10^{+2}$	$3.60 \times 10^{+6}$	$7.21 \times 10^{+6}$
56	Gallium-72	31	$3.55 \times 10^{+1}$	$6.23 \times 10^{+5}$	$1.25 \times 10^{+6}$
57	Germanium-68	32	2.29×10^{0}	$5.27 \times 10^{+5}$	$1.05 \times 10^{+6}$
58	Germanium-71	32	$2.71 \times 10^{+3}$	$5.71 \times 10^{+7}$	$1.14 \times 10^{+8}$
59	Arsenic-73	33	$3.20 \times 10^{+1}$	$2.63 \times 10^{+6}$	$5.27 \times 10^{+6}$
60	Arsenic-74	33	$1.42 \times 10^{+1}$	$5.27 \times 10^{+5}$	$1.05 \times 10^{+6}$
61	Arsenic-76	33	$3.24 \times 10^{+1}$	$4.28 \times 10^{+5}$	$8.56 \times 10^{+5}$
62	Arsenic-77	33	$7.09 \times 10^{+1}$	$1.71 \times 10^{+6}$	$3.42 \times 10^{+6}$
63	Selenium-73	34	$1.24 \times 10^{+2}$	$1.76 \times 10^{+6}$	$3.51 \times 10^{+6}$
64	Selenium-75	34	$1.75 \times 10^{+1}$	$2.63 \times 10^{+5}$	$5.27 \times 10^{+5}$

SCHEDULE 2—DISPOSAL (continued)

Item	Radionuclide	Atomic No.	Release to Air Activity Concentration (Bq/m^3)	Release to Water Activity Concentration (Bq/m^3)	Release to Sewerage System Activity Concentration (Bq/m^3)
65	Bromine-75	35	$3.50 \times 10^{+2}$	$8.67 \times 10^{+6}$	$1.73 \times 10^{+7}$
66	Bromine-76	35	$5.13 \times 10^{+1}$	$1.49 \times 10^{+6}$	$2.98 \times 10^{+6}$
67	Bromine-82	35	$3.38 \times 10^{+1}$	$1.27 \times 10^{+6}$	$2.54 \times 10^{+6}$
68	Krypton-74[1,2]	36	-	-	-
69	Krypton-76[2]	36	$8.56 \times 10^{+2}$	-	-
70	Krypton-77[2]	36	$3.51 \times 10^{+2}$	-	-
71	Krypton-79[2]	36	$1.41 \times 10^{+3}$	-	-
72	Krypton-81[2]	36	$6.52 \times 10^{+4}$	-	-
73	Krypton-83m[2]	36	$6.52 \times 10^{+6}$	-	-
74	Krypton-85m[2]	36	$2.32 \times 10^{+3}$	-	-
75	Krypton-85[2]	36	$6.23 \times 10^{+4}$	-	-
76	Krypton-87[2]	36	$4.03 \times 10^{+2}$	-	-
77	Krypton-88[2]	36	$1.63 \times 10^{+2}$	-	-
78	Rubidium-81	37	$4.38 \times 10^{+2}$	$1.27 \times 10^{+7}$	$2.54 \times 10^{+7}$
79	Rubidium-86	37	$2.29 \times 10^{+1}$	$2.45 \times 10^{+5}$	$4.89 \times 10^{+5}$
80	Strontium-85m	38	$4.02 \times 10^{+3}$	$1.12 \times 10^{+8}$	$2.25 \times 10^{+8}$
81	Strontium-85	38	$3.87 \times 10^{+1}$	$1.22 \times 10^{+6}$	$2.45 \times 10^{+6}$
82	Strontium-87m	38	$8.51 \times 10^{+2}$	$2.08 \times 10^{+7}$	$4.15 \times 10^{+7}$
83	Strontium-89	38	3.97×10^{0}	$2.63 \times 10^{+5}$	$5.27 \times 10^{+5}$
84	Strontium-90[3]	38	1.99×10^{-1}	$2.45 \times 10^{+4}$	$4.89 \times 10^{+4}$
85	Strontium-91	38	$5.22 \times 10^{+1}$	$9.01 \times 10^{+5}$	$1.80 \times 10^{+6}$
86	Strontium-92	38	$8.76 \times 10^{+1}$	$1.40 \times 10^{+6}$	$2.80 \times 10^{+6}$
87	Yttrium-90	39	$1.75 \times 10^{+1}$	$2.54 \times 10^{+5}$	$5.07 \times 10^{+5}$
88	Yttrium-91m	39	$1.99 \times 10^{+3}$	$6.23 \times 10^{+7}$	$1.25 \times 10^{+8}$
89	Yttrium-91	39	3.55×10^{0}	$2.85 \times 10^{+5}$	$5.71 \times 10^{+5}$
90	Yttrium-92	39	$1.06 \times 10^{+2}$	$1.40 \times 10^{+6}$	$2.80 \times 10^{+6}$
91	Yttrium-93	39	$4.96 \times 10^{+1}$	$5.71 \times 10^{+5}$	$1.14 \times 10^{+6}$
92	Zirconium-93[3]	40	1.03×10^{0}	$2.45 \times 10^{+6}$	$4.89 \times 10^{+6}$
93	Zirconium-95	40	5.41×10^{0}	$7.78 \times 10^{+5}$	$1.56 \times 10^{+6}$
94	Zirconium-97[3]	40	$2.13 \times 10^{+1}$	$3.26 \times 10^{+5}$	$6.52 \times 10^{+5}$
95	Niobium-93m	41	$3.46 \times 10^{+1}$	$5.71 \times 10^{+6}$	$1.14 \times 10^{+7}$
96	Niobium-94	41	6.62×10^{-1}	$4.03 \times 10^{+5}$	$8.06 \times 10^{+5}$
97	Niobium-95	41	$1.86 \times 10^{+1}$	$1.18 \times 10^{+6}$	$2.36 \times 10^{+6}$
98	Niobium-97	41	$4.14 \times 10^{+2}$	$1.01 \times 10^{+7}$	$2.01 \times 10^{+7}$

SCHEDULE 2—DISPOSAL (continued)

Item	Radionuclide	Atomic No.	Release to Air Activity Concentration (Bq/m^3)	Release to Water Activity Concentration (Bq/m^3)	Release to Sewerage System Activity Concentration (Bq/m^3)
99	Niobium-98	41	$3.01 \times 10^{+2}$	$6.23 \times 10^{+6}$	$1.25 \times 10^{+7}$
100	Molybdenum-90	42	$5.32 \times 10^{+1}$	$1.10 \times 10^{+6}$	$2.21 \times 10^{+6}$
101	Molybdenum-93	42	$1.35 \times 10^{+1}$	$2.63 \times 10^{+5}$	$5.27 \times 10^{+5}$
102	Molybdenum-99[3]	42	$2.71 \times 10^{+1}$	$5.71 \times 10^{+5}$	$1.14 \times 10^{+6}$
103	Molybdenum-101	42	$6.62 \times 10^{+2}$	$1.63 \times 10^{+7}$	$3.26 \times 10^{+7}$
104	Technetium-95m	43	$3.42 \times 10^{+1}$	$1.10 \times 10^{+6}$	$2.21 \times 10^{+6}$
105	Technetium-96m	43	$2.71 \times 10^{+3}$	$5.27 \times 10^{+7}$	$1.05 \times 10^{+8}$
106	Technetium-96	43	$2.98 \times 10^{+1}$	$6.23 \times 10^{+5}$	$1.25 \times 10^{+6}$
107	Technetium-97m	43	9.61×10^{0}	$1.04 \times 10^{+6}$	$2.08 \times 10^{+6}$
108	Technetium-97	43	$1.42 \times 10^{+2}$	$8.25 \times 10^{+6}$	$1.65 \times 10^{+7}$
109	Technetium-99m	43	$1.03 \times 10^{+3}$	$3.11 \times 10^{+7}$	$6.23 \times 10^{+7}$
110	Technetium-99	43	7.64×10^{0}	$8.78 \times 10^{+5}$	$1.76 \times 10^{+6}$
111	Ruthenium-97	44	$1.86 \times 10^{+2}$	$4.57 \times 10^{+6}$	$9.13 \times 10^{+6}$
112	Ruthenium-103	44	$1.06 \times 10^{+1}$	$9.38 \times 10^{+5}$	$1.88 \times 10^{+6}$
113	Ruthenium-105	44	$1.19 \times 10^{+2}$	$2.63 \times 10^{+6}$	$5.27 \times 10^{+6}$
114	Ruthenium-106[3]	44	4.80×10^{-1}	$9.78 \times 10^{+4}$	$1.96 \times 10^{+5}$
115	Rhodium-103m	45	$1.19 \times 10^{+4}$	$1.80 \times 10^{+8}$	$3.60 \times 10^{+8}$
116	Rhodium-105	45	$6.77 \times 10^{+1}$	$1.85 \times 10^{+6}$	$3.70 \times 10^{+6}$
117	Palladium-103	46	$7.44 \times 10^{+1}$	$3.60 \times 10^{+6}$	$7.21 \times 10^{+6}$
118	Palladium-109	46	$5.96 \times 10^{+1}$	$1.25 \times 10^{+6}$	$2.49 \times 10^{+6}$
119	Silver-105	47	$3.72 \times 10^{+1}$	$1.46 \times 10^{+6}$	$2.91 \times 10^{+6}$
120	Silver-110m	47	2.48×10^{0}	$2.45 \times 10^{+5}$	$4.89 \times 10^{+5}$
121	Silver-111	47	$1.75 \times 10^{+1}$	$5.27 \times 10^{+5}$	$1.05 \times 10^{+6}$
122	Cadmium-109	48	3.10×10^{0}	$3.42 \times 10^{+5}$	$6.85 \times 10^{+5}$
123	Cadmium-115m	48	$4.08 \times 10^{+0}$	$2.08 \times 10^{+5}$	$4.15 \times 10^{+5}$
124	Cadmium-115	48	$2.29 \times 10^{+1}$	$4.89 \times 10^{+5}$	$9.78 \times 10^{+5}$
125	Indium-111	49	$9.61 \times 10^{+1}$	$2.36 \times 10^{+6}$	$4.72 \times 10^{+6}$
126	Indium-113m	49	$9.31 \times 10^{+2}$	$2.45 \times 10^{+7}$	$4.89 \times 10^{+7}$
127	Indium-114m	49	2.71×10^{0}	$1.67 \times 10^{+5}$	$3.34 \times 10^{+5}$
128	Indium-115m	49	$3.42 \times 10^{+2}$	$7.96 \times 10^{+6}$	$1.59 \times 10^{+7}$
129	Tin-113	50	$1.19 \times 10^{+1}$	$9.38 \times 10^{+5}$	$1.88 \times 10^{+6}$
130	Tin-117m	50	$1.29 \times 10^{+1}$	$9.65 \times 10^{+5}$	$1.93 \times 10^{+6}$
131	Tin-121	50	$1.06 \times 10^{+2}$	$2.98 \times 10^{+6}$	$5.96 \times 10^{+6}$
132	Tin-125	50	9.93×10^{0}	$2.21 \times 10^{+5}$	$4.42 \times 10^{+5}$

SCHEDULE 2—DISPOSAL (continued)

Item	Radionuclide	Atomic No.	Release to Air Activity Concentration (Bq/m^3)	Release to Water Activity Concentration (Bq/m^3)	Release to Sewerage System Activity Concentration (Bq/m^3)
133	Antimony-122	51	$2.48 \times 10^{+1}$	$4.03 \times 10^{+5}$	$8.06 \times 10^{+5}$
134	Antimony-124	51	4.88×10^{0}	$2.74 \times 10^{+5}$	$5.48 \times 10^{+5}$
135	Antimony-125	51	6.62×10^{0}	$6.23 \times 10^{+5}$	$1.25 \times 10^{+6}$
136	Tellurium-123m	52	7.64×10^{0}	$4.89 \times 10^{+5}$	$9.78 \times 10^{+5}$
137	Tellurium-125m	52	9.02×10^{0}	$7.87 \times 10^{+5}$	$1.57 \times 10^{+6}$
138	Tellurium-127m	52	4.14×10^{0}	$2.98 \times 10^{+5}$	$5.96 \times 10^{+5}$
139	Tellurium-127	52	$1.65 \times 10^{+2}$	$4.03 \times 10^{+6}$	$8.06 \times 10^{+6}$
140	Tellurium-129m	52	4.73×10^{0}	$2.28 \times 10^{+5}$	$4.57 \times 10^{+5}$
141	Tellurium-129	52	$5.22 \times 10^{+2}$	$1.09 \times 10^{+7}$	$2.17 \times 10^{+7}$
142	Tellurium-131	52	$4.88 \times 10^{+2}$	$7.87 \times 10^{+6}$	$1.57 \times 10^{+7}$
143	Tellurium-131m	52	$1.86 \times 10^{+1}$	$3.60 \times 10^{+5}$	$7.21 \times 10^{+5}$
144	Tellurium-132	52	9.93×10^{0}	$1.85 \times 10^{+5}$	$3.70 \times 10^{+5}$
145	Tellurium-133m	52	$1.57 \times 10^{+2}$	$2.45 \times 10^{+6}$	$4.89 \times 10^{+6}$
146	Tellurium-133	52	$6.77 \times 10^{+2}$	$9.51 \times 10^{+6}$	$1.90 \times 10^{+7}$
147	Tellurium-134	52	$2.71 \times 10^{+2}$	$6.23 \times 10^{+6}$	$1.25 \times 10^{+7}$
148	Iodine-123	53	$2.71 \times 10^{+2}$	$3.26 \times 10^{+6}$	$6.52 \times 10^{+6}$
149	Iodine-124	53	4.73×10^{0}	$5.27 \times 10^{+4}$	$1.05 \times 10^{+5}$
150	Iodine-125	53	4.08×10^{0}	$4.57 \times 10^{+4}$	$9.13 \times 10^{+4}$
151	Iodine-126	53	2.13×10^{0}	$2.36 \times 10^{+4}$	$4.72 \times 10^{+4}$
152	Iodine-129	53	5.84×10^{-1}	$6.23 \times 10^{+3}$	$1.25 \times 10^{+4}$
153	Iodine-130	53	$3.10 \times 10^{+1}$	$3.42 \times 10^{+5}$	$6.85 \times 10^{+5}$
154	Iodine-131	53	2.71×10^{0}	$3.11 \times 10^{+4}$	$6.23 \times 10^{+4}$
155	Iodine-132	53	$1.49 \times 10^{+2}$	$2.36 \times 10^{+6}$	$4.72 \times 10^{+6}$
156	Iodine-133	53	$1.42 \times 10^{+1}$	$1.59 \times 10^{+5}$	$3.19 \times 10^{+5}$
157	Iodine-134	53	$3.77 \times 10^{+2}$	$6.23 \times 10^{+6}$	$1.25 \times 10^{+7}$
158	Iodine-135	53	$6.47 \times 10^{+1}$	$7.36 \times 10^{+5}$	$1.47 \times 10^{+6}$
159	Xenon-131m[2]	54	$4.28 \times 10^{+4}$	-	-
160	Xenon-133[2]	54	$1.14 \times 10^{+4}$	-	-
161	Xenon-135[2]	54	$1.43 \times 10^{+3}$	-	-
162	Caesium-129	55	$3.68 \times 10^{+2}$	$1.14 \times 10^{+7}$	$2.28 \times 10^{+7}$
163	Caesium-131	55	$6.62 \times 10^{+2}$	$1.18 \times 10^{+7}$	$2.36 \times 10^{+7}$
164	Caesium-132	55	$7.84 \times 10^{+1}$	$1.37 \times 10^{+6}$	$2.74 \times 10^{+6}$
165	Caesium-134m	55	$1.15 \times 10^{+3}$	$3.42 \times 10^{+7}$	$6.85 \times 10^{+7}$
166	Caesium-134	55	3.10×10^{0}	$3.60 \times 10^{+4}$	$7.21 \times 10^{+4}$

SCHEDULE 2—DISPOSAL (continued)

Item	Radionuclide	Atomic No.	Release to Air Activity Concentration (Bq/m^3)	Release to Water Activity Concentration (Bq/m^3)	Release to Sewerage System Activity Concentration (Bq/m^3)
167	Caesium-135	55	$3.01 \times 10^{+1}$	$3.42 \times 10^{+5}$	$6.85 \times 10^{+5}$
168	Caesium-136	55	$1.57 \times 10^{+1}$	$2.28 \times 10^{+5}$	$4.57 \times 10^{+5}$
169	Caesium-137[3]	55	4.44×10^{0}	$5.27 \times 10^{+4}$	$1.05 \times 10^{+5}$
170	Caesium-138	55	$6.47 \times 10^{+2}$	$7.44 \times 10^{+6}$	$1.49 \times 10^{+7}$
171	Barium-131	56	$8.51 \times 10^{+1}$	$1.52 \times 10^{+6}$	$3.04 \times 10^{+6}$
172	Barium-133	56	$1.65 \times 10^{+1}$	$6.85 \times 10^{+5}$	$1.37 \times 10^{+6}$
173	Barium-140[3]	56	$1.86 \times 10^{+1}$	$2.74 \times 10^{+5}$	$5.48 \times 10^{+5}$
174	Lanthanum-140	57	$1.99 \times 10^{+1}$	$3.42 \times 10^{+5}$	$6.85 \times 10^{+5}$
175	Cerium-139	58	$1.65 \times 10^{+1}$	$2.63 \times 10^{+6}$	$5.27 \times 10^{+6}$
176	Cerium-141	58	8.27×10^{0}	$9.65 \times 10^{+5}$	$1.93 \times 10^{+6}$
177	Cerium-143	58	$2.98 \times 10^{+1}$	$6.23 \times 10^{+5}$	$1.25 \times 10^{+6}$
178	Cerium-144[3]	58	6.08×10^{-1}	$1.32 \times 10^{+5}$	$2.63 \times 10^{+5}$
179	Praseodymium-142	59	$4.02 \times 10^{+1}$	$5.27 \times 10^{+5}$	$1.05 \times 10^{+6}$
180	Praseodymium-143	59	$1.29 \times 10^{+1}$	$5.71 \times 10^{+5}$	$1.14 \times 10^{+6}$
181	Neodymium-147	60	$1.29 \times 10^{+1}$	$6.23 \times 10^{+5}$	$1.25 \times 10^{+6}$
182	Neodymium-149	60	$2.29 \times 10^{+2}$	$5.71 \times 10^{+6}$	$1.14 \times 10^{+7}$
183	Promethium-147	61	6.34×10^{0}	$2.63 \times 10^{+6}$	$5.27 \times 10^{+6}$
184	Promethium-149	61	$3.63 \times 10^{+1}$	$6.92 \times 10^{+5}$	$1.38 \times 10^{+6}$
185	Samarium-147	62	3.35×10^{-3}	$1.40 \times 10^{+4}$	$2.80 \times 10^{+4}$
186	Samarium-151	62	8.05×10^{0}	$6.99 \times 10^{+6}$	$1.40 \times 10^{+7}$
187	Samarium-153	62	$4.38 \times 10^{+1}$	$9.26 \times 10^{+5}$	$1.85 \times 10^{+6}$
188	Europium-152m	63	$9.31 \times 10^{+1}$	$1.37 \times 10^{+6}$	$2.74 \times 10^{+6}$
189	Europium-152	63	7.64×10^{-1}	$4.89 \times 10^{+5}$	$9.78 \times 10^{+5}$
190	Europium-154	63	5.96×10^{-1}	$3.42 \times 10^{+5}$	$6.85 \times 10^{+5}$
191	Europium-155	63	4.58×10^{0}	$2.14 \times 10^{+6}$	$4.28 \times 10^{+6}$
192	Gadolinium-153	64	$1.19 \times 10^{+1}$	$2.54 \times 10^{+6}$	$5.07 \times 10^{+6}$
193	Gadolinium-159	64	$7.64 \times 10^{+1}$	$1.40 \times 10^{+6}$	$2.80 \times 10^{+6}$
194	Terbium-149	65	6.93×10^{0}	$2.74 \times 10^{+6}$	$5.48 \times 10^{+6}$
195	Terbium-160	65	4.51×10^{0}	$4.28 \times 10^{+5}$	$8.56 \times 10^{+5}$
196	Dysprosium-165	66	$3.42 \times 10^{+2}$	$6.23 \times 10^{+6}$	$1.25 \times 10^{+7}$
197	Dysprosium-166	66	$1.65 \times 10^{+1}$	$4.28 \times 10^{+5}$	$8.56 \times 10^{+5}$
198	Holmium-166	67	$3.59 \times 10^{+1}$	$4.89 \times 10^{+5}$	$9.78 \times 10^{+5}$
199	Erbium-161	68	$3.50 \times 10^{+2}$	$8.56 \times 10^{+6}$	$1.71 \times 10^{+7}$
200	Erbium-169	68	$3.04 \times 10^{+1}$	$1.85 \times 10^{+6}$	$3.70 \times 10^{+6}$

SCHEDULE 2—DISPOSAL (continued)

Item	Radionuclide	Atomic No.	Release to Air Activity Concentration (Bq/m^3)	Release to Water Activity Concentration (Bq/m^3)	Release to Sewerage System Activity Concentration (Bq/m^3)
201	Erbium-171	68	$9.93 \times 10^{+1}$	$1.90 \times 10^{+6}$	$3.81 \times 10^{+6}$
202	Thulium-170	69	4.51×10^{0}	$5.27 \times 10^{+5}$	$1.05 \times 10^{+6}$
203	Thulium-171	69	$2.29 \times 10^{+1}$	$6.23 \times 10^{+6}$	$1.25 \times 10^{+7}$
204	Ytterbium-169	70	$1.06 \times 10^{+1}$	$9.65 \times 10^{+5}$	$1.93 \times 10^{+6}$
205	Ytterbium-175	70	$4.25 \times 10^{+1}$	$1.56 \times 10^{+6}$	$3.11 \times 10^{+6}$
206	Lutetium-177	71	$2.71 \times 10^{+1}$	$1.29 \times 10^{+6}$	$2.58 \times 10^{+6}$
207	Hafnium-181	72	6.34×10^{0}	$6.23 \times 10^{+5}$	$1.25 \times 10^{+6}$
208	Tantalum-182	73	3.07×10^{0}	$4.57 \times 10^{+5}$	$9.13 \times 10^{+5}$
209	Tungsten-181	74	$6.93 \times 10^{+2}$	$8.35 \times 10^{+6}$	$1.67 \times 10^{+7}$
210	Tungsten-185	74	$1.35 \times 10^{+2}$	$1.37 \times 10^{+6}$	$2.74 \times 10^{+6}$
211	Tungsten-187	74	$9.02 \times 10^{+1}$	$9.65 \times 10^{+5}$	$1.93 \times 10^{+6}$
212	Tungsten-188	74	$3.55 \times 10^{+1}$	$2.98 \times 10^{+5}$	$5.96 \times 10^{+5}$
213	Rhenium-186	75	$2.48 \times 10^{+1}$	$4.57 \times 10^{+5}$	$9.13 \times 10^{+5}$
214	Rhenium-188	75	$4.02 \times 10^{+1}$	$4.89 \times 10^{+5}$	$9.78 \times 10^{+5}$
215	Osmium-185	76	$1.99 \times 10^{+1}$	$1.34 \times 10^{+6}$	$2.69 \times 10^{+6}$
216	Osmium-191m	76	$1.99 \times 10^{+2}$	$7.13 \times 10^{+6}$	$1.43 \times 10^{+7}$
217	Osmium-191	76	$1.65 \times 10^{+1}$	$1.20 \times 10^{+6}$	$2.40 \times 10^{+6}$
208	Osmium-193	76	$4.38 \times 10^{+1}$	$8.46 \times 10^{+5}$	$1.69 \times 10^{+6}$
219	Iridium-190	77	$1.19 \times 10^{+1}$	$5.71 \times 10^{+5}$	$1.14 \times 10^{+6}$
220	Iridium-192	77	4.80×10^{0}	$4.89 \times 10^{+5}$	$9.78 \times 10^{+5}$
221	Iridium-194	77	$3.97 \times 10^{+1}$	$5.27 \times 10^{+5}$	$1.05 \times 10^{+6}$
222	Platinum-191	78	$1.57 \times 10^{+2}$	$2.01 \times 10^{+6}$	$4.03 \times 10^{+6}$
223	Platinum-193m	78	$1.42 \times 10^{+2}$	$1.52 \times 10^{+6}$	$3.04 \times 10^{+6}$
224	Platinum-197m	78	$6.93 \times 10^{+2}$	$8.15 \times 10^{+6}$	$1.63 \times 10^{+7}$
225	Platinum-197	78	$1.86 \times 10^{+2}$	$1.71 \times 10^{+6}$	$3.42 \times 10^{+6}$
226	Gold-198	79	$2.71 \times 10^{+1}$	$6.85 \times 10^{+5}$	$1.37 \times 10^{+6}$
227	Gold-199	79	$3.92 \times 10^{+1}$	$1.56 \times 10^{+6}$	$3.11 \times 10^{+6}$
228	Mercury-195m	80	$4.58 \times 10^{+1}$	$1.22 \times 10^{+6}$	$2.45 \times 10^{+6}$
229	Mercury-197m	80	$4.51 \times 10^{+1}$	$1.46 \times 10^{+6}$	$2.91 \times 10^{+6}$
230	Mercury-197	80	$1.03 \times 10^{+2}$	$2.98 \times 10^{+6}$	$5.96 \times 10^{+6}$
231	Mercury-203	80	$1.29 \times 10^{+1}$	$3.60 \times 10^{+5}$	$7.21 \times 10^{+5}$
232	Thallium-200	81	$1.19 \times 10^{+2}$	$3.42 \times 10^{+6}$	$6.85 \times 10^{+6}$
233	Thallium-201	81	$3.92 \times 10^{+2}$	$7.21 \times 10^{+6}$	$1.44 \times 10^{+7}$
234	Thallium-202	81	$9.61 \times 10^{+1}$	$1.52 \times 10^{+6}$	$3.04 \times 10^{+6}$

SCHEDULE 2—DISPOSAL (continued)

Item	Radionuclide	Atomic No.	Release to Air Activity Concentration (Bq/m^3)	Release to Water Activity Concentration (Bq/m^3)	Release to Sewerage System Activity Concentration (Bq/m^3)
235	Thallium-204	81	$4.80 \times 10^{+1}$	$5.27 \times 10^{+5}$	$1.05 \times 10^{+6}$
236	Lead-203	82	$1.86 \times 10^{+2}$	$2.85 \times 10^{+6}$	$5.71 \times 10^{+6}$
237	Lead-210	82	2.71×10^{-2}	$1.01 \times 10^{+3}$	$2.01 \times 10^{+3}$
238	Lead-212	82	9.02×10^{-1}	$1.16 \times 10^{+5}$	$2.32 \times 10^{+5}$
239	Bismuth-206	83	$1.42 \times 10^{+1}$	$3.60 \times 10^{+5}$	$7.21 \times 10^{+5}$
240	Bismuth-207	83	5.73×10^{0}	$5.27 \times 10^{+5}$	$1.05 \times 10^{+6}$
241	Bismuth-210	83	3.55×10^{-1}	$5.27 \times 10^{+5}$	$1.05 \times 10^{+6}$
242	Bismuth-212[3]	83	7.64×10^{-1}	$2.63 \times 10^{+6}$	$5.27 \times 10^{+6}$
243	Bismuth-213	83	7.26×10^{-1}	$3.42 \times 10^{+6}$	$6.85 \times 10^{+6}$
244	Polonium-203	84	$4.88 \times 10^{+2}$	$1.32 \times 10^{+7}$	$2.63 \times 10^{+7}$
245	Polonium-205	84	$3.35 \times 10^{+2}$	$1.16 \times 10^{+7}$	$2.32 \times 10^{+7}$
246	Polonium-207	84	$1.99 \times 10^{+2}$	$4.89 \times 10^{+6}$	$9.78 \times 10^{+6}$
247	Polonium-210	84	9.93×10^{-3}	$2.85 \times 10^{+3}$	$5.71 \times 10^{+3}$
248	Astatine-211	85	2.71×10^{-1}	$6.23 \times 10^{+4}$	$1.25 \times 10^{+5}$
249	Radon-220[2,3]	86	$2.25 \times 10^{+1}$	-	-
250	Radon-222[2,3]	86	$1.12 \times 10^{+2}$	-	-
251	Radium-223[3]	88	4.32×10^{-3}	$6.85 \times 10^{+3}$	$1.37 \times 10^{+4}$
252	Radium-224[3]	88	1.03×10^{-2}	$1.05 \times 10^{+4}$	$2.11 \times 10^{+4}$
253	Radium-225	88	5.13×10^{-3}	$7.21 \times 10^{+3}$	$1.44 \times 10^{+4}$
254	Radium-226[3]	88	1.86×10^{-3}	$2.45 \times 10^{+3}$	$4.89 \times 10^{+3}$
255	Radium-227	88	$1.06 \times 10^{+2}$	$8.15 \times 10^{+6}$	$1.63 \times 10^{+7}$
256	Radium-228[3]	88	1.15×10^{-2}	$1.02 \times 10^{+3}$	$2.04 \times 10^{+3}$
257	Actinium-225	89	3.77×10^{-3}	$2.85 \times 10^{+4}$	$5.71 \times 10^{+4}$
258	Actinium-227	89	4.73 x 10-05	$6.23 \times 10^{+2}$	$1.25 \times 10^{+3}$
259	Actinium-228	89	1.03×10^{0}	$1.59 \times 10^{+6}$	$3.19 \times 10^{+6}$
260	Thorium-226[3]	90	3.82×10^{-1}	$1.90 \times 10^{+6}$	$3.81 \times 10^{+6}$
261	Thorium-227	90	3.10×10^{-3}	$7.70 \times 10^{+4}$	$1.54 \times 10^{+5}$
262	Thorium-228[3]	90	7.64×10^{-4}	$9.78 \times 10^{+3}$	$1.96 \times 10^{+4}$
263	Thorium-229[3]	90	3.01×10^{-4}	$1.43 \times 10^{+3}$	$2.85 \times 10^{+3}$
264	Thorium-230	90	7.44×10^{-4}	$3.26 \times 10^{+3}$	$6.52 \times 10^{+3}$
265	Thorium-231	90	$7.44 \times 10^{+1}$	$2.01 \times 10^{+6}$	$4.03 \times 10^{+6}$
266	Thorium-nat[3]	90	7.09×10^{-4}	$3.11 \times 10^{+3}$	$6.23 \times 10^{+3}$
267	Thorium-234	90	4.08×10^{0}	$2.01 \times 10^{+5}$	$4.03 \times 10^{+5}$
268	Protactinium-230	91	4.19×10^{-2}	$7.44 \times 10^{+5}$	$1.49 \times 10^{+6}$

SCHEDULE 2—DISPOSAL (continued)

Item	Radionuclide	Atomic No.	Release to Air Activity Concentration (Bq/m^3)	Release to Water Activity Concentration (Bq/m^3)	Release to Sewerage System Activity Concentration (Bq/m^3)
269	Protactinium-231	91	2.29×10^{-4}	$9.65 \times 10^{+2}$	$1.93 \times 10^{+3}$
270	Protactinium-233	91	$8.05 \times 10^{+0}$	$7.87 \times 10^{+5}$	$1.87 \times 10^{+6}$
271	Uranium-230[3]	92	1.99×10^{-3}	$1.25 \times 10^{+4}$	$2.49 \times 10^{+4}$
272	Uranium-231	92	$7.44 \times 10^{+1}$	$2.45 \times 10^{+6}$	$4.89 \times 10^{+6}$
273	Uranium-232[3]	92	8.51×10^{-4}	$2.08 \times 10^{+3}$	$4.15 \times 10^{+3}$
274	Uranium-233	92	3.42×10^{-3}	$1.37 \times 10^{+4}$	$2.74 \times 10^{+4}$
275	Uranium-234	92	3.50×10^{-3}	$1.40 \times 10^{+4}$	$2.80 \times 10^{+4}$
276	Uranium-235[3]	92	3.87×10^{-3}	$1.49 \times 10^{+4}$	$2.98 \times 10^{+4}$
277	Uranium-236	92	3.77×10^{-3}	$1.49 \times 10^{+4}$	$2.98 \times 10^{+4}$
278	Uranium-237	92	$1.65 \times 10^{+1}$	$8.90 \times 10^{+5}$	$1.78 \times 10^{+6}$
279	Uranium-238[3]	92	4.08×10^{-3}	$1.56 \times 10^{+4}$	$3.11 \times 10^{+4}$
280	Uranium-nat[3]	92	4.08×10^{-3}	$1.56 \times 10^{+4}$	$3.11 \times 10^{+4}$
281	Uranium-239	92	$8.51 \times 10^{+2}$	$2.45 \times 10^{+7}$	$4.89 \times 10^{+7}$
282	Uranium-240	92	$3.55 \times 10^{+1}$	$6.23 \times 10^{+5}$	$1.25 \times 10^{+6}$
283	Neptunium-237[3]	93	1.42×10^{-3}	$6.23 \times 10^{+3}$	$1.25 \times 10^{+4}$
284	Neptunium-239	93	$2.71 \times 10^{+1}$	$8.56 \times 10^{+5}$	$1.71 \times 10^{+6}$
285	Neptunium-240	93	$2.29 \times 10^{+2}$	$8.35 \times 10^{+6}$	$1.67 \times 10^{+7}$
286	Plutonium-234	94	1.35×10^{0}	$4.28 \times 10^{+6}$	$8.56 \times 10^{+6}$
287	Plutonium-235	94	$1.15 \times 10^{+4}$	$3.26 \times 10^{+8}$	$6.52 \times 10^{+8}$
288	Plutonium-236	94	1.65×10^{-3}	$7.96 \times 10^{+3}$	$1.59 \times 10^{+4}$
289	Plutonium-237	94	$8.27 \times 10^{+1}$	$6.85 \times 10^{+6}$	$1.37 \times 10^{+7}$
290	Plutonium-238	94	6.93×10^{-4}	$2.98 \times 10^{+3}$	$5.96 \times 10^{+3}$
291	Plutonium-239	94	6.34×10^{-4}	$2.74 \times 10^{+3}$	$5.48 \times 10^{+3}$
292	Plutonium-240	94	6.34×10^{-4}	$2.74 \times 10^{+3}$	$5.48 \times 10^{+3}$
293	Plutonium-241	94	3.50×10^{-2}	$1.46 \times 10^{+5}$	$2.91 \times 10^{+5}$
294	Plutonium-242	94	6.77×10^{-4}	$2.85 \times 10^{+3}$	$5.71 \times 10^{+3}$
295	Plutonium-243	94	$2.71 \times 10^{+2}$	$8.06 \times 10^{+6}$	$1.61 \times 10^{+7}$
296	Plutonium-244	94	6.77×10^{-4}	$2.85 \times 10^{+3}$	$5.71 \times 10^{+3}$
297	Americium-241	95	7.64×10^{-4}	$3.42 \times 10^{+3}$	$6.85 \times 10^{+3}$
298	Americium-242m[3]	95	8.51×10^{-4}	$3.60 \times 10^{+3}$	$7.21 \times 10^{+3}$
299	Americium-242	95	1.86×10^{0}	$2.28 \times 10^{+6}$	$4.57 \times 10^{+6}$
300	Americium-243[3]	95	7.64×10^{-4}	$3.42 \times 10^{+3}$	$6.85 \times 10^{+3}$
301	Curium-242	96	6.20×10^{-3}	$5.71 \times 10^{+4}$	$1.14 \times 10^{+5}$
302	Curium-243	96	1.03×10^{-3}	$4.57 \times 10^{+3}$	$9.13 \times 10^{+3}$

SCHEDULE 2—DISPOSAL (continued)

Item	Radionuclide	Atomic No.	Release to Air Activity Concentration (Bq/m^3)	Release to Water Activity Concentration (Bq/m^3)	Release to Sewerage System Activity Concentration (Bq/m^3)
303	Curium-244	96	1.19×10^{-3}	$5.71 \times 10^{+3}$	$1.14 \times 10^{+4}$
304	Curium-245	96	7.44×10^{-4}	$3.26 \times 10^{+3}$	$6.52 \times 10^{+3}$
305	Curium-246	96	7.44×10^{-4}	$3.26 \times 10^{+3}$	$6.52 \times 10^{+3}$
306	Curium-247	96	8.27×10^{-4}	$3.60 \times 10^{+3}$	$7.21 \times 10^{+3}$
307	Curium-248	96	2.13×10^{-4}	$8.90 \times 10^{+2}$	$1.78 \times 10^{+3}$
308	Berkelium-249	97	1.99×10^{-1}	$7.06 \times 10^{+5}$	$1.41 \times 10^{+6}$
309	Californium-246	98	7.09×10^{-2}	$2.08 \times 10^{+5}$	$4.15 \times 10^{+5}$
310	Californium-248	98	3.63×10^{-3}	$2.45 \times 10^{+4}$	$4.89 \times 10^{+4}$
311	Californium-249	98	4.51×10^{-4}	$1.96 \times 10^{+3}$	$3.91 \times 10^{+3}$
312	Californium-250	98	9.31×10^{-4}	$4.28 \times 10^{+3}$	$8.56 \times 10^{+3}$
313	Californium-251	98	4.44×10^{-4}	$1.90 \times 10^{+3}$	$3.81 \times 10^{+3}$
314	Californium-252	98	1.65×10^{-3}	$7.61 \times 10^{+3}$	$1.52 \times 10^{+4}$
315	Californium-253	98	2.48×10^{-2}	$4.89 \times 10^{+5}$	$9.78 \times 10^{+5}$
316	Californium-254	98	8.05×10^{-4}	$1.71 \times 10^{+3}$	$3.42 \times 10^{+3}$
317	Einsteinium-253	99	1.19×10^{-2}	$1.12 \times 10^{+5}$	$2.25 \times 10^{+5}$
318	Einsteinium-254m	99	6.77×10^{-2}	$1.63 \times 10^{+5}$	$3.26 \times 10^{+5}$
319	Einsteinium-254	99	3.72×10^{-3}	$2.45 \times 10^{+4}$	$4.89 \times 10^{+4}$
320	Fermium-254	100	3.87×10^{-1}	$1.56 \times 10^{+6}$	$3.11 \times 10^{+6}$
321	Fermium-255	100	1.15×10^{-1}	$2.74 \times 10^{+5}$	$5.48 \times 10^{+5}$

[1] Nuclides with very short half lives (less than 10 minutes)

[2] Inert gases

[3] Nuclides which are in secular equilibrium with their progeny

Appendix 1

GLOSSARY

activity concentration of a radionuclide is defined as meaning the concentration of the radionuclide measured in becquerels per stated mass in grams of the radioactive material.

activity of a radionuclide is defined as meaning a measure of the rate of spontaneous nuclear transformation of the radionuclide.

alpha particle means a charged particle, consisting of two protons and two neutrons, emitted by the nucleus of a radionuclide during radioactive decay.

analysis refers to analysis of material involving X-ray diffraction, absorption or fluorescence, to determine the elemental composition or to examine the microstructure of the material. The analysing tool may incorporate a sealed radioactive substance or a radiation apparatus. Applications of "analysis" include alloy analysis for checking stock and components and in mining to analyse material excavated from pits, cores and slurries. Analysing devices are used in universities, scientific institutes and many industrial locations (eg. mine sites).

borehole logging involving a sealed radioactive substance makes use of a sealed radioactive substance for geological analysis of a borehole.

becquerel means the unit of radiation equal to 1 transformation per second.

Bq means a becquerel.

cabinet radiation apparatus means a radiation apparatus as defined by the National Health and Medical Research Council's *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes* (1987).

calibration means the check or correction of the accuracy of a measuring instrument to assure proper operational characteristics.

compliance testing in relation to a radiation source or premises where a radiation source is used to carry out a radiation practice, means the

assessment of the source or premises by an accredited person, for compliance with the relevant radiation safety standard.

cosmetic procedures refers to the use of Class IV lasers for the aesthetic enhancement of the body; for example to remove tattoos, blemishes, wrinkles, hair etc.

depleted uranium is metallic uranium that contains less than 0.72% of Uranium 235, which is the amount found in naturally occurring uranium. Depleted uranium is obtained from used fuel elements or as by-product residues from uranium isotope separation. Depleted uranium can be used for radiation shielding in industrial radiography containers, for the keels of ships, and for ballast in the noses of aircraft.

effective dose means the sum of weighted equivalent doses in all organs and tissues of the body.

enclosed radiation apparatus is a radiation apparatus which is wholly enclosed by interlocked barriers and/or shields and so designed that it can be used in ways which involve no possibility of exposure of any person to the primary X-ray beam.

equivalent dose means a weighted dose in an organ or tissue, with the radiation weighting factor(s) determined by the type and energy of the radiation to which the tissue of organ is exposed.

gaseous tritium light device is an instrument, piece of equipment, article or subassembly containing one or more sealed glass containers filled with gaseous tritium and coated internally with a phosphor. These devices are installed in a fixed position and produce a light for many safety applications, for example as warning signs in underground mines. Negligible radiation is emitted from these devices.

GBq means a gigabecquerel.

gigabecquerel means 1 000 000 000 becquerels.

gray means the unit of absorbed dose or absorbed energy and is equal to 1 joule per kilogram of irradiated material.

Gy means a gray.

industrial gauging is the means used to analyse, measure, and in some cases control, the thickness, level, density, weight or moisture content of certain materials. The principle of operation in each case depends on

the detection of a beam of radiation transmitted through or scattered by the item or material of interest. Industrial gauges may use either a sealed radioactive substance or ionising radiation apparatus to produce the radiation.

kBq means a kilobecquerel.

kilobecquerel means 1 000 becquerels.

marker source means a radiation source that is used for transferring anatomical landmarks to images that are captured using a gamma camera.

microgray means 1/1 000 000 part of a gray and may be designated by the symbol 'μGy'.

microsievert means the 1/1 000 000 part of a sievert and may be designated by the symbol 'μSv'.

millisievert means 1/1 000 part of a sievert and may be designated by the symbol 'mSv'.

MBq means a megabecquerel.

megabecquerel means 1 000 000 becquerels.

mSv means a millisievert.

nuclear medicine is the application of radionuclides for the diagnosis and treatment of patients.

nuclear medicine scan (or image) means an image produced by a gamma camera imaging system.

pathology is the branch of medicine that studies the causes, nature and effects of diseases. Such study may be in-vivo (within the living organism) or in-vitro (in an artificial environment outside the living organism). For the purposes of the legislation, "pathology" will be restricted to mean in-vitro tests only. In-vivo tests will be treated as a part of nuclear medicine.

product irradiator means equipment that uses a sealed radioactive substance for irradiating objects or materials. Product irradiation involves the exposure of an item, such as medical equipment, food, imported goods (eg. wooden artefacts, leather products), to an intense beam of radiation for sterilisation.

quality control procedures means routine tests carried out on a radiation source or aspects of a radiation practice to ensure its satisfactory performance or operation.

radiograph means an image produced on a film by the use of X-rays.

sievert means the SI unit of radiation dose equivalent. It may be designated by the symbol 'Sv'. 1 Sv = 1 joule of radiation energy absorbed per kilogram mass of the irradiated object.

Sv means a sievert.

unintended events means any unintended event, including operating errors, equipment failure or other mishaps, the consequences or potential consequences of which are not negligible from the point of view of radiation protection or safety.

***μ*Gy** means a microgray.

***μ*Sv** means a microsievert.

Appendix 2

DERIVATION OF RADIONUCLIDE CONCENTRATIONS FOR DISPOSAL INTO AIR, WATER AND SEWERAGE

1. Disposal into air and water

a. As airborne effluents

The maximum concentrations for the disposal of radionuclides into the environment as airborne effluents have been determined as follows:

$$C_{air} = \frac{D}{2 \cdot I_{inh} \cdot e} = \frac{A}{2 \cdot I_{inh}}$$

Where C_{air} = maximum concentration for the disposal of radionuclides in air

I_{inh} = annual inhalation rate

D = half the member of the public effective dose limit = 500 microsieverts per annum

e = dose coefficient

A = activity of the radionuclides resulting in a committed effective dose equal to 'D'

The annual inhalation rate for workers has been derived from table 6 of the International Commission on Radiological Protection (ICRP), Publication No. 66 *Human Respiratory Tract Model for Radiological Protection,* which states a daily intake of 23 m^3 (23000 litres) of air. The annual inhalation rate will be 365 times this figure, or 8395 m^3 (8395000 litres). It is therefore assumed, as a worse case scenario, that a person would inhale 8395 m^3 of contaminated air per year.

The value *A* obtained after dividing the effective dose limit by the dose coefficients represents the activities of radionuclides that would produce a committed effective dose of 500 μSv in a year.

The values for C_{air} will then be obtained after a further division of these activities by the intake per year, which is 8395m^3. An additional reduction to half the value is considered to adjust for differences in ages (USA Nuclear Regulatory Commission: *Part 20: Standards for Protection Against Radiation*, Appendix B). The dose coefficient *e* for every radionuclide is obtained from the International Commission on Radiological Protection, Publication No 68 *Dose Coefficients for Intakes of Radionuclides by Workers*.

b. As waterborne effluents

The maximum concentrations for the disposal of radionuclides into the environment as waterborne effluents have been determined as follows:

$$C_{water} = \frac{D}{I_{ing} \cdot e} = \frac{A}{I_{ing}}$$

Where C_{water} = maximum concentration for the disposal of radionuclides in water

I_{ing} = annual ingestion rate

D = half the member of the public effective dose limit = 500 microsieverts per annum

e = dose coefficient

A = activity of the radionuclides resulting in a committed effective dose equal to 'D'

The annual ingestion rate has been determined by assuming that a person would drink 2 litres of contaminated liquid in a day, which over a year would be 730 litres, or 0.73 m^3 of total liquid intake (USA Nuclear Regulatory Commission: Part 20, Appendix B).

The value for C_{water} will then be the quotients resulting from the activities of radionuclides that would produce a committed effective dose of 500 μSv in a year divided by the intake per year, which is 0.73 m^3 of contaminated water, as a worst case scenario. The dose coefficient *e* for every radionuclide is obtained from the International Commission on Radiological Protection, Publication No 68.

2. Disposal into the sewerage system

Maximum concentrations of radionuclides in sewerage have been determined in the same way as for water, except that the activities considered in this case would produce an annual committed effective dose of 1000 μSv instead of 500 μSv. Effectively, the concentration limits for sewerage are twice those for water.

Appendix 3

CALCULATION OF DISPOSAL FACTOR

Disposal factor is determined as follows—

(i) For each radionuclide, determine the ratio between the activity concentration of the radionuclide in the mixture (the first concentration), and the activity concentration for the radionuclide specified in Column 4, 5 or 6 (depending upon the proposed method of disposal) of Schedule 2 (the second concentration). This is achieved by dividing the first concentration by the second concentration.

(ii) Add each of the figures obtained in (i) to reach the disposal factor for the mixture.

(iii) If the disposal factor calculated is less than or equal to one (1), then the mixture may be disposed of as air or water borne effluent, or into the sewerage system, as the case may be.

This calculation may be expressed mathematically as follows —

$$\text{DF (Disposal Factor)} = \frac{ACx}{MPACx} + \frac{ACy}{MPACy} + \frac{ACz}{MPACz}$$

Where: DF is the sum of ratios, for each of the radionuclides in the mixture, of the activity concentration of the radionuclide and its maximum permissible activity concentration.

ACx is the activity concentration of the radionuclide “x” in the mixture.

ACy is the activity concentration of the radionuclide “y” in the mixture.

ACz is the activity concentration of the radionuclide “z” in the mixture.

MPACx is the maximum permissible activity concentration for the radionuclide “x” specified in Column 4, 5 or 6 of Schedule 2 (depending upon the proposed method of disposal).

MPACy is the maximum permissible activity concentration for the radionuclide "y" specified in Column 4, 5 or 6 of Schedule 2 (depending upon the proposed method of disposal).

MPACz is the maximum permissible activity concentration for the radionuclide "z" specified in Column 4, 5, or 6 of Schedule 2 (depending upon the proposed method of disposal).

Appendix 4

DISPOSAL EXAMPLE

Calculation of Disposal Factor

A radioactive material is proposed to be disposed of into the sewerage system. The material contains the radionuclides Cobalt-60, Technetium-99 and Iodine-131. The actual activity concentrations of each of these radionuclides in the mixture are as follows:

Cobalt-60: $1.21 \times 10^{+5}$ Bq/m^3 = 121 Bq/litre

Technetium-99: $8.88 \times 10^{+5}$ Bq/m^3 = 880 Bq/litre

Iodine-131: $1.87 \times 10^{+4}$ Bq/m^3 = 18.7 Bq/litre

Column 6 of Schedule 2 shows the following maximum permissible activity concentration limits for release to the sewerage system:

Cobalt-60: $4.03 \times 10^{+5}$ Bq/m^3 = 403 Bq/litre

Technetium-99: $1.76 \times 10^{+6}$ Bq/m^3 = 1,760 Bq/litre

Iodine-131: $6.23 \times 10^{+4}$ Bq/m^3 = 62.3 Bq/litre

Then, according to the formula to be used to calculate the disposal factor in the mixture:

DF = 0.3 + 0.5 + 0.3 = 1.1

In this case, DF has been calculated to be greater than one (1). Therefore, the radioactive material containing this mixture of radionuclides must not be released into the sewerage system.

One of the following options must then be applied in order to dispose of the radioactive material:

- Storage of the radioactive material for sufficient time to allow for decay of the radionuclides to the permissible activity concentration limits for disposal.
- Dilution of the mixture of radionuclides to achieve permissible activity concentration limits for disposal.
- A combination of both storage and dilution to achieve permissible activity concentration limits for disposal.

- Application to the chief executive for an approval to dispose of the radioactive material in its existing state.

Appendix 5

PROPOSED RELEASE CRITERIA FOR ABRASIVE BLASTING MATERIAL CONTAINING THORIUM AND URANIUM SERIES RADIONUCLIDES

Persons undertaking abrasive blasting using material comprised mainly of the thorium series and uranium series radionuclides, will receive an effective radiation dose (D_{total}) equal to the sum of the committed effective dose due to inhalation and ingestion ($D_{inh+ing}$) and the effective dose (D_{ext}) due to external exposure from the material. This may be described using the following expression:

$$D_{Total} \cong D_{inh+ing} + D_{ext}$$

Natural uranium (U-nat) is composed of the uranium series radionuclides present in the Uranium-238, Uranium-235 and Uranium-234 decay chains. Natural thorium (Th-nat) is composed of the radionuclides in the Thorium-232 decay chain. For natural uranium the mass fractions of the uranium isotopes are known to be 99.28% U-238, 0.71% U-235 and 0.0058% U-234.

In calculating the release criteria for abrasive blasting material containing thorium and uranium series radionuclides, the following assumptions have been made:

- ***The inhaled particle size***

  1 μm AMAD (activity median aerodynamic diameter) particle size has been shown from field measurements to be representative of airborne blasting dust in some situations (International Commission on Radiological Protection, Publication No. 68 *Dose Coefficients for Intakes of Radionuclides by Workers*). This value has been chosen for conservative purposes, over larger particle sizes, and used in the determination of the annual limits on intake. AMAD relates to a deposition fraction as a function of particle size.

- ***Respirable dust concentration inside protective breathing apparatus***

  The concentration of respirable dust in an abrasive blasting workplace may be greater than 100 $mg \cdot m^{-3}$. The estimated concentration inside protective helmets used in abrasive blasting should nominally be 1000 times less. In practice the desired protection is not always achieved due to poor hygiene and work practices. Typically, reductions between 20 to 40 times are obtained (as advised by the Division of Workplace Health and Safety, Queensland Department of Employment, Training and Industrial Relations, July 1999).

  Assuming that the abrasive blasting material that contains radionuclides follows dust patterns similar to other abrasive blasting materials when used for abrasive blasting and the protective breathing apparatus provides a reduction factor of 20, the dust concentration inside the protective breathing apparatus is 5 $mg \cdot m^{-3}$.

- ***Breathing rate***

  The standard breathing rate for inhalation of radionuclides by abrasive blasting workers for these calculations is 1.5 $m^3 \cdot h^{-1}$. This is the breathing rate for light exercise. (International Commission on Radiological Protection, Publication No. 66 *Human Respiratory Tract Model for Radiological Protection* and Publication No. 68 *Dose Coefficients for Intakes of Radionuclides by Workers*).

- ***Time spent in close proximity to abrasive blasting material***

  In 1993, the Association of Abrasive Blastcleaners & Protective Coaters Qld Inc (now called Blast Cleaning and Coating Association Qld Inc) provided written advice that the number of hours operators are physically engaged in abrasive blasting using abrasive material that contains radionuclides is between 1000 to 1500 hours per year. Recent advice from this organisation indicates that the this number has not changed.

  In estimating the radiation dose it is also important to take into account the time a person may be in the vicinity of the material in addition to the time spent using it.

  The Radiation Health Committee (comprised of State/Territory and Commonwealth radiation regulatory authorities) has proposed that the

time an abrasive blasting worker spends using and in close proximity to the abrasive blasting material is 1700 hours per year.

- ***Annual Limits on Intake (inhalation)***

  The annual limits on intake (ALI) due to the inhalation of dust containing uranium and thorium series radionuclides in abrasive blasting material have been obtained from the biokinetic clearance model and methodology proposed in O'Brien's *Dose Calculations for Intakes of Ore Dust* (1998). The ALI values relate to the activity of an element or mixture which will yield an annual committed effective dose of 20 mSv. For natural uranium and thorium, these are:

  $$ALI^{(inh)}_{U\text{-}nat} = 5560 \text{ Bq}$$

  $$ALI^{(inh)}_{Th\text{-}nat} = 2960 \text{ Bq}$$

  Note: In determining the release criteria the ALI values have been corrected to account for the recommended member of public limit of 1 mSv per annum.

- ***Annual Limits on Intake (ingestion)***

  The annual limits on intake due to the ingestion of dust particles containing uranium and thorium series radionuclides in abrasive blasting material has been calculated to be more than 70 times lower than the annual limit on intake for inhalation. Additionally, the amount of ingestible radioactive material per annum in worst-case scenarios has been determined to be no more than 3 times the amount of inhaled material.

  From these and other considerations, it is possible to show that the radiation dose arising from ingestion is considered insignificant compared with that from inhalation.

- ***Dose rate per unit activity concentration***

  The radiation dose rates ($Sv \cdot s^{-1}$) per unit activity concentration ($Bq \cdot m^{-3}$) for the uranium series and thorium series radionuclides have been obtained from the Federal Guidance Report No. 12—*External Exposure to Radionuclides in Air, Water and Soil*, by KF Eckerman & JC Ryman, *United States Environmental Protection Agency*, (1993). These figures have been used in estimating the effective dose from external exposure doses to the abrasive blasting worker.

Release Criteria

If the practice of abrasive blasting is to be exempt from the application of the system of protection recommended by the International Commission on Radiological Protection, the effective dose received at work by persons engaged in abrasive blasting operations using abrasive material containing radionuclides must not exceed 1 mSv per annum.

The Commonwealth and State/Territory radiation regulatory authorities have agreed that a dose constraint of half the annual pro-rata member of public dose limit, i.e., 0.5 mSv or 500 μSv: should be applied to persons who may be exposed to radiation as a consequence of abrasive blasting.

This may be expressed as:

$$\frac{D_{inh\ +ing} + D_{ext}}{0.0005} \leq 1$$

Therefore, the release criteria that should be met by any material containing natural uranium or thorium series radionuclides which is intended for abrasive blasting purposes will be:

$$0.7 \quad N_{Unat}\ (Bq\ .\ g^{-1}) \quad + \quad 1.0_{Thnat}\ (Bq\ .\ g^{-1}) \quad \leq \quad 1$$

Appendix 6

EXAMPLES OF THE APPLICATION OF FEES

1. An engineering company wishes to apply for new licences (for one year) to possess:

(i) two sealed source apparatus, each containing two sealed radioactive substances (Americium241/Beryllium and Caesium137) for density and moisture measurements; and

(ii) the unsealed radioactive substances Scandium46, Iridium192 and Antimony 124 for tracer studies.

The following licence costs will be associated with this scenario.

For the new application, the company will need to pay:

(i) for the sealed radioactive substances in the sealed source apparatus—

$100 initial application fee

$120 licence fee (per year)

$40 for the radioactive sources (ie. $10 for each item of sealed radioactive substance)

(ii) for the unsealed radioactive substances—

$100 initial application fee

$120 licence fee (per year)

$30 for the radioactive sources (ie. $10 x 3)

Total new application fees = $510.00

To renew the licences, the company will need to pay:

(i) for the sealed radioactive substances in the sealed source apparatus—

$120 licence fee (per year)

$40 for the radioactive sources ($10 x 4)

(ii) for the unsealed radioactive substances—

$120 licence fee (per year)

$30 for the radioactive sources ($10 x 3)

Total renewal fees per year = $310.00

2. An employee of a research institute wishes to apply for a new licence (for one year) to use and transport Barium133 and Caesium137 for research.

The applicant will need to pay a fee to apply for a use licence, and a fee to apply for a transport licence.

The following licence costs will be associated with this scenario.

The new application fees will be made up of:

(i) for the use licence—

$50 initial application fee

$35 licence fee (per year)

(ii) for the transport licence—

$50 initial application fee

$35 licence fee (per year)

Total new application fees = $170.00

The renewal application fees (for one year) will be made up of:

(i) for the use licence—

$35 licence fee (per year)

(ii) for the transport licence—

$35 licence fee (per year)

Total renewal application fees per year = $70.00

3. A public hospital wishes to apply for a new licence (for one year) to possess 3 dental X-ray units, 5 diagnostic X-ray units, and 2 therapy X-ray units.

The hospital will need to pay for a licence to possess radiation apparatus for diagnostic purposes and to possess radiation apparatus for therapy purposes.

The following licence costs will be associated with this scenario.

The total application fees for the new licences would be:

(i) for a licence to possess radiation sources for diagnostic radiography—

$100 initial application fee

$120 licence fee (per year)

$160 for the radiation apparatus ($20 x 8)

(ii) for a licence to possess radiation sources for radiation therapy—

$100 initial application fee

$120 licence fee (per year)

$40 for the radiation apparatus ($20 x 2)

Total new application fees = $640.00

To renew these licences, the renewal fees would be:

(i) for a licence to possess radiation sources for diagnostic radiography—

$120 licence fee (per year)

$160 for the radiation apparatus ($20 x 8)

(ii) for a licence to possess radiation apparatus for radiation therapy—

$120 licence fee (per year)

$40 for the radiation apparatus ($20 x 2)

Total renewal fees per year = $440.00

4. A person who wishes to use diagnostic and therapy equipment will need to apply only for one licence.

The following licence costs (for one year) will be associated with this scenario.

The new application fee would be:

$50 initial application fee

$35 licence fee (per year)

Total new application fee = $85.00

To renew this licence, the person will need to pay:

$35 licence fee (per year)

Total renewal fee per year = $35.00

Appendix 7

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ATTACHMENT 2

RADIATION SAFETY STANDARDS

LEGISLATIVE PROPOSAL

Queensland Department of Health

July 1999

CONTENTS

INTRODUCTION

The *Radiation Safety Act 1999* provides for the introduction of a new process to ensure that radiation sources, including the premises at which they are to be stored or used, meet specified safety standards.

Section 16 of the Act provides for the making of radiation safety standards by the Minister for Health. These standards may be made about:

(a) Sealed radioactive substances and radiation apparatus (i.e. radiation sources) in relation to the carrying out of radiation practices;

(b) the sealing of radioactive substances;

(c) sealed source apparatus;

(d) premises at which radiation sources are used to carry out radiation practices; or

(e) premises at which radioactive substances are stored.

Radiation safety standards will be technical in nature. For example, a standard about a radiation source used to carry out a radiation practice will set out the minimum requirements against which a source is to be assessed in order to determine that it is not only safe to operate, but reliable and accurate. More specifically, the minimum requirements for a source will specify matters in relation to radiation output, radiation leakage, operating controls and indicators, automatic exposure and tomographic functions, collimators, etc. A standard about premises at which the source is to be used to carry out a radiation practice will specify the minimum requirements for radiation shielding and engineered controls (such as interlocks and illuminated warning signs) in the premises or that part of a premises where the source is to be used.

The radiation safety standards detailed in this paper have been developed with reference to recognised standards, specifications and protocols published by bodies such as the Standards Association of Australia, the National Health and Medical Research Council, the National Occupational Health and Safety Committee, the American Association of Physicists in Medicine and the Royal Australasian College of Radiology.

As part of the radiation safety and protection framework provided for under the *Radiation Safety Act 1999*, possession licensees must ensure that:

(a) a radiation source or a sealed source apparatus in their possession is not used unless it complies with the relevant radiation safety standard;

(b) a radiation source or sealed source apparatus in their possession is not used at premises, unless the premises comply with the relevant radiation safety standard;

(c) radioactive substances in their possession are not stored at premises, unless the premise complies with the relevant radiation safety standard.

More specifically, the legislation requires a possession licensee to periodically obtain a certificate of compliance for a radiation source, a sealed source apparatus or premises to demonstrate that the source, apparatus or premises continues to comply with the relevant radiation safety standards. The period within which a possession licensee must obtain a certificate of compliance is to be prescribed under a regulation. The Legislative Proposal for the Radiation Safety Regulations (Queensland Health, July 1999) sets out the proposed time frames within which such certificates must be obtained.

Should a possession licensee fail to meet these obligations, the licensee may be charged with the commission of an offence under the Act and, if convicted of the offence, liable for the maximum penalty specified under the Act.

The legislation makes provision for certificates of compliance to be issued by accredited persons. That is, persons who have been granted an accreditation certificate by the Chief Executive of Queensland Health under the *Radiation Safety Act 1999.* The accreditation certificate issued to a person will specify the types of radiation sources, sealed source apparatus or premises for which an accredited person may issue a certificate of compliance.

A register of accredited persons is to be maintained by Queensland Health. Information comprising this register will be publicly accessible so that possession licensees and other persons can avail themselves of information as to:

(a) who has been issued with an accreditation certificate;

(b) the date on which this certificate expires; and

(c) the type of radiation sources, sealed source apparatus or premises for which an accredited person may issue a certificate of compliance.

In order to provide guidance to both accredited persons and possession licensees, the Act sets out the process, time frames and documentation requirements for the certification of a radiation source or premises. In summary the Act provides for the following:

- If an accredited person is acting on a request for a certificate of compliance, the accredited person is required to assess whether a radiation source or premises, complies with the relevant radiation safety standards.
- The accredited person must prepare an assessment report in the approved form, which states:
  - (a) whether the radiation source or premises complies with the relevant radiation safety standards; and
  - (b) if not, what needs to be done in order for the source or premises to comply with the relevant standard (the "requirements").
- If the assessment report pertaining to a source or premises states that the source or premises complies with the relevant radiation safety standard, the accredited person must issue a certificate of compliance.
- If the assessment report sets out requirements, the person who requested the certificate of compliance has 30 days within which to meet the requirements. This 30-day period commences once the accredited person has given the report to the person.
- If all of the requirements set out in an assessment report have been met within the 30 day period, the accredited person may amend the assessment report to indicate that all the requirements have been complied with and then issue a certificate of compliance.
- If only some of the requirements set out in an assessment report have been met within the 30-day period, the accredited person may amend the assessment report to indicate which requirements have been met.

- In addition to providing a copy of an assessment report or an amended assessment report to the person who requested the certificate of compliance, the accredited person must also provide a copy of these reports to the chief executive of Queensland Health.

RADIATION SAFETY STANDARDS

RADIATION SOURCES IN RELATION TO THE CARRYING OUT A RADIATION PRACTICE

It is intended that a radiation safety standard be made about:

- Radiation apparatus in relation to the carrying out of health related diagnostic radiography, including research involving medical diagnostic radiography. The minimum requirements for this standard as detailed in Table 1 cover general diagnostic radiography, fluoroscopy, computed tomography and mammography.
- Radiation apparatus in relation to the carrying out of intra-oral dental diagnostic radiography, including research involving intra-oral dental diagnostic radiography. The minimum requirements for this standard are detailed in Table 2.
- Class IV lasers in relation to the carrying out of diagnostic, therapeutic or cosmetic on human beings, including research into the use of this radiation apparatus for these purposes. The minimum requirements for this standard are detailed in Table 20.
- Radiation apparatus in relation to the carrying out of veterinary diagnostic radiography. The minimum requirements for this standard are detailed in Table 3.
- A sealed radioactive substance incorporated into sealed source apparatus, for the carrying out of industrial radiography. The minimum requirements for this standard are detailed in Table 4.
- Radiation apparatus in relation to the carrying out of industrial radiography. The minimum requirements for this standard are detailed in Table 5.
- Radiation apparatus in relation to the carrying out of fluoroscopic or radiographic imaging of inanimate objects. The minimum requirements for this standard are detailed in Table 6.
- A sealed radioactive substance incorporated into sealed source apparatus, for the carrying out of chemical analysis. The minimum requirements for this standard are detailed in Table 7.
- Radiation apparatus in relation to the carrying out of chemical

analysis. The minimum requirements for this standard are detailed in Table 8.

- A sealed radioactive substance incorporated into sealed source apparatus, for the carrying out of industrial gauging. The minimum requirements for this standard are detailed in Table 9.
- Radiation apparatus in relation to the carrying out of industrial gauging. The minimum requirements for this standard are detailed in Table 10.
- A sealed radioactive substance incorporated into sealed source apparatus, for the carrying out of borehole logging. The minimum requirements for this standard are detailed in Table 11.
- A sealed radioactive substance incorporated into sealed source apparatus, for the carrying out of moisture/density measurements. The minimum requirements for this standard are detailed in Table 12.

THE SEALING OF RADIOACTIVE SUBSTANCES

It is proposed that a radiation safety standard be made about the sealing of radioactive substances. This standard will adopt the minimum requirements specified in the International Organization for Standardization (ISO) 2919 "*Sealed radioactive sources—Classification*". This document sets out minimum requirements regarding the sealing of radioactive substances in relation to particular radiation practices such as borehole logging, industrial radiography, chemical analysis, and soil moisture density measurements.

PREMISES AT WHICH RADIATION SOURCES ARE USED TO CARRY OUT RADIATION PRACTICES

It is proposed that a radiation safety standard be made about:

- Premises at which radiation apparatus is used to carry out medical or dental diagnostic radiography or radiation therapy. The minimum requirements for this standard are detailed in Table 13.
- Premises at which Class IV lasers are used to carry out diagnostic, therapeutic or cosmetic procedures. The minimum requirements for this standard are detailed in Table 21.
- Premises at which radiation apparatus is used to carry out

veterinary diagnostic radiography or radiation therapy. The minimum requirements for this standard are detailed in Table 14.

- Premises at which radioactive substances are used to carry out a radiation practice. The minimum requirements for this standard are detailed in Table 15.
- Premises, excluding open sites, at which radioactive substances or ionising radiation apparatus are used to carry out industrial radiography. The minimum requirements for this standard are detailed in Table 16.
- Premises at which radiation apparatus is used to carry out chemical analysis. The minimum requirements for this standard are detailed in Table 17.
- Premises at which radioactive substances or ionising radiation apparatus are used to carry out industrial gauging. The minimum requirements for this standard are detailed in Table 18.

PREMISES AT WHICH RADIOACTIVE SUBSTANCES ARE STORED

It is proposed that a radiation safety standard be made about premises at which radioactive substances are stored. The minimum requirements for this standard are detailed in Table 19.

GLOSSARY

The following terms are used throughout the minimum requirements for the radiation safety standards detailed in Tables 1 to 19.

cabinet radiation apparatus means a radiation apparatus as defined by the *NHMRC Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes (1987)* and which is used for fluoroscopic or radiographic imaging of objects or goods.

controlled area means an area to which access is subject to control and in which employees are required to follow specific procedures aimed at controlling exposure to radiation.

enclosed unit means a radiation apparatus used for chemical analysis which is wholly enclosed by interlocked barriers and/or shields and so designed that it can only be used in ways which involve no possibility

of exposure of any person to the primary X-ray beam.

field site is a place which is not solely dedicated to the carrying out a radiation practice.

fully enclosed site means a premises used specifically for industrial radiography in which the irradiation area is completely enclosed by shielding, including walls, floor and ceiling, and within which no person is permitted to remain during exposure

gray means the unit of absorbed dose and is equal to 1 joule per kilogram of irradiated material.

ISO means the International Organization for Standardization.

kVp means the potential difference applied to an X-ray tube between the anode and the cathode which is expressed by its peak value in kilovolts (kVp).

mA means the electric current of the electron beam incident on the target of an X-ray tube, which is expressed by its mean value in milliamperes (mA).

mAs means the electric current of the electron beam incident on the target of an X-ray tube over a particular time, which is expressed by multiplying the mean value in milliamperes by the seconds (mAs).

microsievert means the 1/1 000 000 part of a sievert and may be designated by the symbol 'μSv'.

millisievert means the 1/1 000 part of a sievert and may be designated by the symbol 'mSv'.

mirogray means the 1/1 000 000 part of a gray and may be designated by the symbol 'μGy'.

milligray means the 1/1 000 part of a sievert and may be designated by the symbol 'mGy'.

open site means an area in which industrial radiography is carried out and, due to operational requirements, the shielding afforded by a fully enclosed site or a partially enclosed site cannot be provided and for which a clearly marked boundary is set up and strict control of access and occupancy is observed.

partly enclosed unit means a radiation apparatus used for chemical

analysis, which is partly enclosed by interlocked barriers and/or shields or partly or wholly enclosed by fixed barriers and/or shielding which require the use of tools for removal and is so designed that, in its normal use there is no possibility of an inadvertent exposure of any person to the primary X-ray beam.

partially enclosed site means a premises used for industrial radiography in which all objects exposed to direct radiation are completely contained inside a permanent, shielded enclosure having walls at least 2.1 metres high but typically open at the top to permit the transfer in and out of the objects to be radiographed, and within which no person is permitted to remain during exposure.

public area means any area that is neither controlled nor supervised.

radiation dose rate means the amount of energy from radiation absorbed by the person or thing exposed to the radiation over a particular time.

Sievert means the SI unit of radiation dose equivalent. It may be designated by the symbol 'Sv'. 1 Sv equals 1 joule of radiation energy absorbed per kilogram mass of the irradiated object.

store means a place (such as a building, room or cupboard) where a radiation source is stored when not in use.

supervised area means an area in which working conditions are kept under review but in which special procedures to control exposure to radiation are not normally necessary.

Table 1—Standard For Radiation Apparatus Used To Carry Out Health Related Diagnostic Radiography

General Diagnostic Radiography

Test	Compliance Test	Criteria for Passing the Test	Reference
1	Grid uniformity	The density of the film must be uniform within ±0.10 in optical density from side to side, perpendicular to the anode-cathode axis.	WA Workbook 3 (5.1), NCRP 99 (7.3.1)
2	X-ray tube stationary	The X-ray tube must remain stationary during loading unless it is intended to move.	AS/NZS 3200.1.3:1996 #29.204.1 Appendix ZZ
Radiation Output			
3	Reproducibility	The coefficient of variation of radiation output must not exceed 0.05.	WA Workbook 3 (3.5), AS/NZS 3200.2.7:1994 #50.101.1
4	Linearity	The coefficient of linearity between any two radiation output measurements must be less than or equal to 0.1.	WA Workbook 3 (3.4)
5	kVp accuracy	The kVp accuracy must be ± 5 percent or ±5kVp whichever is the lesser of the indicated value.	WA Workbook 3 (3.2)
6	Timer accuracy	The required exposure time accuracy must be ±10 percent for exposure times greater than or equal to 0.1 seconds and ±20 percent for exposure times less than 0.1 seconds.	WA Workbook 3 (3.3), AS/NZS 3200.2.7:1994 #50.102.2

Test	Compliance Test	Criteria for Passing the Test	Reference
7	Beam quality—half value layer	(a) The total filtration must be such that the measured half-value layers are equal to or greater than 3.0 millimetres of aluminium at 110 kVp; and (b) The total filtration must be such that the measured half-value layers are equal to or greater than 2.3 millimetres of aluminium at 80 kVp	AS/NZS 3200.1.3:1996 #29.201.2
Beam limiting device			
8	Minimum focus to skin distance	The minimum distance from the focus to the skin must not be less than 200 millimetres.	AS/NZS 3200.1.3:1996 #29.205.1 Appendix ZZ Table 205
9	Light field intensity	The light field intensity must be greater than or equal to 100 lux at 1 metre from the focal spot of the X-ray tube.	WA Workbook 3 (2.3), AS/NZS 3200.1.3:1996 #29.202.7
10	X-ray/light beam alignment	(a) The extent of misalignment between any boundary of the light beam and the equivalent boundary of the X-ray beam in the plane of the image receptor must not exceed 1 percent of the focus to film distance; and (b) For a 20 centimetre high test tool, the distance between the images of the test objects must not exceed 5 millimetres.	WA Workbook 3 (2.2), AS/NZS 3200.1.3:1996 #29.202.9

Test	Compliance Test	Criteria for Passing the Test	Reference
11	X-ray vs image receptor (positive beam limitation)	(a) Along each of the major axes of the image reception area, the total of the discrepancies between the edges of the X-ray field and the corresponding edges of the image reception area must not exceed 3 percent of the focus to image receptor distance; and (b) The sum of the absolute values of the differences (X-ray field difference from image receptor size) for the length and width must not exceed 4 percent of the focus to image receptor distance; and (c) The centre of the light field must be within 20 millimetres of the centre of the film.	AS/NZS 3200.1.3:1996 #29.203.4, NCRP 99 (7.1.2)
12	X-ray vs image receptor (cephalometric mode)	(a) The X-ray field must not exceed the size of the image receptor; and (b) The minimum focal spot to mid-sagittal plane distance must not be less than 1500 millimetres.	AS/NZS 3200.2.201:1996 #29.107.3.2 AS/NZS 3200.2.201:1996 #29.107.3.3

Test	Compliance Test	Criteria for Passing the Test	Reference
13	X-ray height vs slot height (panoramic mode)	(a) The X-ray beam from the primary collimator must fall within the top and bottom borders of the secondary collimator and within the top and bottom borders of the film; and (b) The width of the X-ray beam must not exceed the width of the secondary collimator; and (c) Lateral misalignment of the primary beam and secondary collimator must not exceed 1millimetre.	WA Workbook 5 (3.3), AS/NZS 3200.2.201:1996 #29.107.2
Leakage radiation			
14	X-ray source assembly	The leakage radiation dose rate must not exceed 1mGy in one hour at 1 metre with the X-ray tube operating at the maximum rated voltage and the maximum rated continuous current.	AS/NZS 3200.1.3:1996 #29.204.3
15	Condenser discharge units—discharge mode	The leakage radiation dose rate from condenser discharge units in the discharge mode must not exceed 1.0mGy in one hour.	AS/NZS 3200.1.3:1996 #29.204.4
16	Condenser discharge units—charge/ preparation mode	The leakage radiation dose rate from condenser discharge units in the charge preparation mode, averaged over an area of 10 square centimetres, must not exceed 20µGy in one hour.	AS/NZS 3200.1.3:1996 #29.204.5

Test	Compliance Test	Criteria for Passing the Test	Reference
Control panel			
17	Hand switch cord—mobile	The hand switch cord must be at least 2 metres in length.	AS/NZS 3200.1.3:1996 #29.208.1
18	Supply indicator	The supply indicator of radiation apparatus that may be used in a cephalometric or panoramic mode must be indicated by a green light indicating power ON.	AS/NZS 3200.2.201:1996 #29.101.3
19	Indication if more than one X-ray tube	If more than one X-ray tube can be operated from the same control panel, there must be: (a) A signal at the control panel indicating the X-ray tube selected; and (b) A visible indication at or near the X-ray tube selected (this may not be possible in the case of enclosed under-couch tubes).	AS/NZS 3200.2.7:1994 #29.1.103(c)
20	Exposure switches protected	All exposure switches must be protected against accidental actuation.	AS/NZS 3200.2.7:1994 #29.1.104(e)
21	Exposure switches “dead-man”	The exposure time recorded must be less than the preset exposure time and correspond to the time of actuation by the operator.	AS/NZS 3200.2.7:1994 #29.1.104(b)
22	Loading indication	Loading in the intermittent mode must be indicated by an amber or yellow light and an audible signal.	AS/NZS 3200.2.201:1996 #29.101.4 AS/NZS 3200.2.7:1994 #29.1.103

Test	Compliance Test	Criteria for Passing the Test	Reference
Automatic Exposure Control			
23	Control panel	There must be an indication on the control panel that the automatic exposure control function has been selected.	AS/NZS 3200.2.7:1994 #29.1.103(d)
24	Indication of detector(s) selected	There must be an indication on the control panel of the actual detectors selected.	WA Workbook 3 (4.2)
25	Backup timer	The backup timer must terminate the exposure after 600mAs has been delivered or at 6 seconds whichever is the lesser. A preset exposure time of less than 6 seconds also constitutes a backup time.	AS/NZS 3200.2.7:1994 #29.1.105(d), NRL C5 (5.29)
26	Visual signal when exposure hits backup	A visible indication at the control panel must be provided whenever a loading has been terminated by the backup timer.	AS/NZS 3200.2.7:1994 #29.1.105(g)
27	Manual reset prior to another loading	When the exposure has been stopped by the backup timer it must not be possible to initiate another exposure without first operating a manual reset.	AS/NZS 3200.2.7:1994 #29.1.105(g)
28	Reproducibility	(a) All exposures for the centre chamber must be ± 5 percent of the mean; and (b) The exposures for the lateral detectors must be ±5 percent of each other and ±20 percent of the centre chamber.	WA Workbook 3 (4.3), NCRP 99 (7.2.8)

Test	Compliance Test	Criteria for Passing the Test	Reference
29	kVp compensation	The optical density of the films, when exposed to several kVp settings, must be within 20 percent of the mean.	WA Workbook 3 (4.4)
30	Thickness compensation	The optical density of the films, using different thicknesses of a patient equivalent phantom, must be within 20 percent of the mean.	WA Workbook 3 (4.5)
Tomographic performance			
31	Resolution	The system must resolve a 40 mesh (1.6 holes/millimetre) screen pattern or better.	NCRP 99 (10), Gray et al (1983)
32	Cut thickness	The cut thickness must comply with manufacturer's specifications.	NCRP 99 (10), Gray et al (1983)
33	Cut location	Agreement between the indicated and measured levels must be within ± 5 millimetres.	NCRP 99 (10), Gray et al (1983)
34	Exposure uniformity and pattern	The density of the image of the hole in the lead sheet of the phantom must be nearly uniform or must vary in uniformity according to the pattern expected. The image must reveal no unexpected overlaps, Inconsistencies of exposure or asymmetry in motion.	NCRP 99 (10), Gray et al (1983)

Fluoroscopy

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation output			
1	Reproducibility	The coefficient of variation of radiation output must not exceed 0.05.	WA Workbook 3 (3.5), AS/NZS 3200.2.7:1994 #50.101.1
2	Linearity	The coefficient of linearity between any two radiation output measurements must be less than or equal to 0.1.	WA Workbook 3 (3.4)
3	kVp accuracy	The required kVp accuracy must be ± 5 percent or ± 5kVp of the average kVp whichever is the lesser of the indicated value.	WA Workbook 3 (3.2)
4	Timer accuracy	The required exposure time accuracy must be ± 10 percent for exposure times greater than or equal to 0.1 seconds and ± 20 percent for exposure times less than 0.1 seconds.	WA Workbook 3 (3.3), AS/NZS 3200.2.7:1994 #50.102.2
5	Beam quality—half value layer	(a) The total filtration must be such that the measured half-value layers are equal to or greater than 3.0 millimetres of aluminium at 110 kVp; and (b) The total filtration must be such that the measured half-value layers are equal to or greater than 2.3 millimetres of aluminium at 80 kVp	AS/NZS 3200.1.3:1996 #29.201.2

Test	Compliance Test	Criteria for Passing the Test	Reference
Leakage radiation			
6	X-ray source assembly	The leakage radiation dose rate must not exceed 1mGy in one hour at 1 metre with the X-ray tube operating at the maximum rated voltage and the maximum rated continuous current.	AS/NZS 3200.1.3:1996 #29.204.3
Control panel			
7	Hand switch cord—mobile image intensifier	The hand switch cord must be at least 2 metres in length.	AS/NZS 3200.1.3:1996 #29.208.1
8	Exposure switches protected	All exposure switches must be protected against accidental actuation.	AS/NZS 3200.2.7:1994 #29.1.104(e)
9	Exposure switches “dead-man”	The exposure time recorded must correspond to the time of actuation by the operator.	AS/NZS 3200.2.7:1994 #29.1.104(b)
10	Timer requires reset every 5 minutes	(a) The fluoroscopic timer must provide an audible signal to the fluoroscopist at intervals not exceeding 5 minutes; and (b) Provision must be made for the display to be reset to zero for each patient. Resetting of the audible alarm need not necessarily also reset the timer to zero.	WA Workbook 4 (5.1), AS/NZS 3200.2.7:1994 #29.1.105(b)

Test	Compliance Test	Criteria for Passing the Test	Reference
11	Loading indication—intermittent mode	Loading in the intermittent mode must be indicated by an amber or yellow light and an audible signal.	AS/NZS 3200.2.7:1994 #29.1.103(b)
12	Loading indication—continuous mode	Loading in the continuous mode must be indicated by a yellow light on the control panel and at the serial changer.	AS/NZS 3200.2.7:1994 #29.1.103
13	Loading factors	Loading factors must be continuously displayed at the control panel.	AS/NZS 3200.2.7:1994 #50.1.103
Automatic exposure control			
14	Indication on control	There must be an indication on the control panel that the automatic exposure control function has been selected.	AS/NZS 3200.2.7:1994 #29.1.103(d)
15	Indication of detector(s) selected	There must be an indication on the control panel of the actual detectors selected.	WA Workbook 3 (4.2)
16	Back-up timer	The backup timer must terminate the exposure after 600mAs has been delivered or at 6 seconds whichever is the lesser. A preset exposure time of less than 6 seconds also constitutes a backup time.	AS/NZS 3200.2.7:1994 #29.1.105(d), NRL C5 (5.29)
17	Visible signal when exposure hits backup	A visible indication at the control panel must be provided whenever a loading has been terminated by the backup timer.	AS/NZS 3200.2.7:1994 #29.1.105(g)

Test	Compliance Test	Criteria for Passing the Test	Reference
18	Manual reset prior to another loading	When the exposure has been stopped by the backup timer it must not be possible to initiate another exposure without first operating a manual reset.	AS/NZS 3200.2.7:1994 # 29.1.105(g)
19	Reproducibility	(a) All exposures for the centre chamber must be ± 5 percent of the mean; and (b) The exposures for the lateral detectors must be ± 5 percent of each other and ±20 percent of the centre chamber.	WA Workbook 3 (4.3), NCRP 99 (7.2.8)
20	kVp compensation	The optical density of the films, when exposed to several kVp settings, must be within 20 percent of the mean.	WA Workbook 3 (4.4)
21	Thickness compensation	The optical density of the films, using different thicknesses of a patient equivalent phantom, must be within 20 percent of the mean.	WA Workbook 3 (4.5)

Test	Compliance Test	Criteria for Passing the Test	Reference
Grid uniformity			
22	Film density	The density of the film must be uniform within ± 0.10 in optical density from side to side, perpendicular to the anode-cathode axis.	WA Workbook 3 (5.1), NCRP 99 (7.3.1)
Protective drapes			
23	Protective drapes	(a) The protective drapes attached to the spot film device must fully cover the gap between the serial changer and the table top when the table is in the horizontal position and the spot film device is at its highest point; and (b) All protective drapes must not be less than 0.5 millimetre lead equivalence.	WA Workbook 4 (6.1 d)
Bucky slot cover			
24	Bucky slot cover	All conventional under table fluoroscopic equipment must be fitted with bucky slot shielding not less than 0.5 millimetre lead equivalence.	WA Workbook 4 (6.1 e)

Test	Compliance Test	Criteria for Passing the Test	Reference
Protective screen			
25	Size and shielding of screens	All protective screens must be at least 2.1 metres high and 1 metre wide and be not less than 1.3 millimetres lead equivalence.	WA Workbook 4 (6.1c,d,e,f)
Initiation of fluoroscopic exposures			
26	Image receptor in place	It must not be possible to initiate fluoroscopic exposures without an image receptor in place to fully intercept the X-ray beam.	WA Workbook 4 (6.1c,d,e,f)
X-ray field vs image receptor			
27	Fluoroscopy	The size of the X-ray beam must not exceed the area imaged on the television monitor by more than 1 percent of the focus to image receptor distance.	WA Workbook 4 (4.2)
28	Radiography	(a) The X-ray beam must not exceed the image area selected by more than 1 percent of the focus to film distance at any point; and (b) All spot exposures must be appropriately positioned and clear of each other; and (c) If the X-ray beam is circular, the diameter of the X-ray beam must not exceed the smaller dimension of the cassette.	AS/NZS 3200.1.3:1996 #29.203.4 Appendix ZZ

Test	Compliance Test	Criteria for Passing the Test	Reference
High level boost control			
29	Separate control switch	A separate control must activate the high level (boost) function of the radiation apparatus.	WA Workbook 4 (5.2)
30	Switch “dead-man” or return to normal	The control must either be of the “dead-man” type or the radiation apparatus must return to normal operation after 5 minutes.	WA Workbook 4 (5.2)
31	Loading indication	There must be additional audible and visual signals to indicate that the high level (boost) function is being activated.	WA Workbook 4 (5.2)
Radiation dose rates			
32	Radiation dose rates during fluoroscopy	The radiation dose rates during fluoroscopy must not exceed the following values: Manual mode 50mGy in one minute Automatic mode 100mGy in one minute High level or boost mode 150mGy in one minute	AS/NZS 3200.1.3:1996 #29.209 Appendix ZZ

Test	Compliance Test	Criteria for Passing the Test	Reference
33	Radiation dose rates at the input surface of the image intensifier	The radiation dose rates at the input surface of the image intensifier must not exceed the following values: **Field size (millimetre)** — **Air kerma radiation dose rate (µGy in one minute)** 110 to < 140 — 120 140 to < 230 — 80 ≥ 230 — 60	AS/NZS 3200.1.3:1996 #29.209 Appendix ZZ
Image quality			
34	Image distortion	The pin cushion distortion must be no greater than ± 2 percent.	WA Workbook 4 (4.4)
35	High contrast resolution	The high contrast resolution must not be worse than: (a) 1.2 line pairs per millimetre for 25centimetre/23centimetre field sizes; and (b) 1.6 line pairs per millimetre for 15centimetre/13centimetre field sizes.	WA Workbook 4 (4.4)

Test	Compliance Test	Criteria for Passing the Test	Reference
36	Low contrast resolution	The low contrast resolution must not be worse than: (a) 5 percent for 10 millimetre diameter detail (at least 9 of the 10 millimetre circles should be detectable); and (b) 15 percent for a 1millimetre diameter detail (for the Westmead test object 1.5 millimetres on the low contrast detectability section which is 10 percent is acceptable).	WA Workbook 4 (4.4)
Mobile image intensifiers			
37	Cassette holder if radiographic capability	If the apparatus is capable of operation in the radiographic mode, a cassette holder that attaches to the front of the image intensifier must be used when the apparatus is used in the radiographic mode.	AS/NZS 3200.1.3:1996 #29.203.4 Appendix ZZ
X-ray field vs image receptor			
38	Fluoroscopy	The size of the X-ray beam must not exceed the area imaged on the television monitor by more than 1 percent of the focus to image receptor distance.	AS/NZS 3200.1.3:1996 #29.203.4 Appendix ZZ

Test	Compliance Test	Criteria for Passing the Test	Reference
39	Radiography	(a) The X-ray beam must be centered to the center of the cassette; and (b) The X-ray beam must not exceed the image area selected; and (c) If circular, the diameter of the X-ray beam must not exceed the smaller dimension of the collimation size selected.	AS/NZS 3200.1.3:1996 #29.203.4 Appendix ZZ

Computed Tomography

Test	Compliance Test	Criteria for Passing the Test	Reference
1	Scan can be interrupted by operator	The operator must be able to interrupt the scan at any time.	AS/NZS 4184.2.6:1995 #5.1
2	Loading indication	Loading indication must be by a yellow or amber light and an audible signal both at the control console and in the computed tomography room.	AS/NZS 3200.2.7:1994 #29.1.103
3	Couch positioning accuracy	The couch positioning accuracy must not deviate by more than 2 millimetres.	AS/NZS 4184.2.6:1995 #5.5
4	Room warning lights	(a) Warning lights must be installed outside all unlocked entrances to the computed tomography scanner room with the possible exception of the access door between the control panel and the scanner room; and (b) These warning lights must be connected into the X-ray generator circuit so that they illuminate for the duration of the exposure; and (c) The warning lights must be mounted with the bottom of the light between 1.4 and 1.8 metres above the floor and one side of the light no more than 100 millimetres from the door on the wall adjacent to the door handle.	WA Workbook 6 (4.2)

Test	Compliance Test	Criteria for Passing the Test	Reference
Slice characterisation			
5	Light localisation accuracy	The error of scan localisation light and scan plane must not exceed ± 2.0 millimetres.	AAPM 39 III A 1
6	Scout localisation accuracy	There must be no error in the correspondence of localisation image parameters with actual slice position and angle.	AAPM 39 III A 14
7	Radiation beam width	The width of the radiation beam must be less than the slice thickness plus 1 millimetre.	AAPM 39 III A 6a
8	Slice thickness	The actual width of an imaged slice compared with the width selected must be within: (a) 1.0 millimetres for thicknesses above 2 millimetres; and (b) 50 percent for thicknesses of 2 millimetres or less.	AS/NZS 4184.2.6:1995 #5.3
System performance			
9	Noise	The value of noise must not deviate from the baseline value by more than 10 percent or 0.2 Hounsfield units whichever is the larger.	AS/NZS 4184.2.6:1995 #5.1

Test	Compliance Test	Criteria for Passing the Test	Reference
10	Uniformity	With respect to uniformity, the difference between the mean computed tomography number of the central region of interest and the outer regions of interest must not vary by more than 2 Hounsfield units from those of the baseline values.	AS/NZS 4184.2.6:1995 #5.1
11	Computed tomography number	The mean computed tomography number of the central region of interest must fall within ± 4 Hounsfield units of the baseline.	AS/NZS 4184.2.6:1995 #5.1
12	Computed tomography number linearity	The plot of computed tomography number versus linear attenuation coefficient must be a straight line passing through computed tomography number zero for water.	WA Workbook 6 (3.4)
13	System resolution	The modulation must remain within ± 15 percent of the baseline.	AS/NZS 4184.2.6:1995 #5.2
14	Computed tomography dose index	The computed tomography dose index must be within ± 20 percent of the baseline value.	AS/NZS 4184.2.6:1995 #5.4

Mammography

Test	Compliance Test	Criteria for Passing the Test	Reference
Grids			
1	Grids	The appropriate grids must be available.	WA Workbook 2 (5.4)
Radiation dose rate			
2	Radiation dose rate	The system must be capable of: (a) Producing a minimum radiation dose rate of 7.0 mGy in one second when operating at 28 kVp in the standard mammography (Mo/Mo) mode at any focus to film distance where the system is designed to operate and when measured by a detector with its centre located 4.5 centimetres above the breast support surface with the compression paddle in place between the source and the detector; and (b) Maintaining the required minimum output averaged over a 3 second period.	Mammography Quality Standard Act (USA)
3	Reproducibility	The coefficient of variation of radiation output must not exceed 0.05.	National Program for the Early Detection of Breast Cancer (1994) Appendix 4.
4	Linearity	The coefficient of linearity between any two radiation output measurements must be less than or equal to 0.1.	WA Workbook 2 (3.4)

Test	Compliance Test	Criteria for Passing the Test	Reference
5	kVp accuracy	The required kVp accuracy must be ± 1kVp.	National Program for the Early Detection of Breast Cancer (1994) Appendix 4.
6	Timer accuracy	The required exposure time accuracy must be ± 5 percent.	WA Workbook 2 (3.3)
7	Beam quality—half value layer	The half value layer of the X-ray beam must not be less than kVp/100 + 0.03 but must not be greater than kVp/100 + C. where C = 0.12 millimetres of Aluminium for an X-ray tube with a molybdenum anode and a molybdenum filter. 0.19 millimetres of Aluminium for an X-ray tube with a molybdenum anode and a rhodium filter. 0.22 millimetres of Aluminium for an X-ray tube with a rhodium anode and a rhodium filter. For the test, all radiation dose measurements must be taken with the compression paddle in the X-ray beam.	American College of Radiology 1994.

Test	Compliance Test	Criteria for Passing the Test	Reference
Beam limiting device			
8	Light field intensity	The light field intensity must be greater than or equal to 100 lux.	WA Workbook 2 (2.2)
9	X-ray field/light beam alignment	The extent of misalignment between any boundary of the light beam and the equivalent boundary of the X-ray beam in the plane of the image receptor must not exceed 1 percent of the focus to film distance.	AS/NZS 3200.1.3:1996 #29.202.9
10	X-ray field/image receptor alignment	The X-ray field must: (a) Extend to the edge of the image receptor but must not extend beyond the edge of the image receptor holder, with the exception of the edge adjacent to the patient chest wall; and (b) Extend to the edge of the breast support that is designed to be adjacent to the chest wall but must not extend beyond this by more than 1 percent of the focal spot to image receptor distance.	AS/NZS 3200.1.3:1996 #29.203.4 Appendix ZZ

Test	Compliance Test	Criteria for Passing the Test	Reference
Leakage radiation			
11	X-ray source assembly	The leakage radiation dose must not exceed 0.01mGy per 100mAs at 0.3 metres and 30kVp.	National Program for the Early Detection of Breast Cancer (1994) Appendix 4.
Compression			
12	Compression	(a) The maximum force exerted by the compression paddle must not exceed 200 Newtons in the automatic mode, and 300 Newtons in the manual mode; and (b) The inner lip of the chest wall side of the compression paddle must be aligned just beyond the chest wall edge of the image receptor by a distance not exceeding 1 percent of the focus to film distance.	IEC 601-2-45 American College of Radiology, Mammography Quality Control Manual (1999)
Control panel			
13	Exposure switch	Each loading must be initiated and maintained by means of a control requiring continuous actuation by the operator.	AS/NZS 3200.2.7:1994 # 29.1.104(b)
14	Loading indication	Loading must be indicated by an amber or yellow light and an audible signal.	AS/NZS 3200.2.7:1994 #29.1.103(b)

Test	Compliance Test	Criteria for Passing the Test	Reference
Automatic exposure control			
15	Selection indication	There must be an indication on the control panel that the automatic exposure control function has been selected.	AS/NZS 3200.2.7:1994 #29.1.103(d)
16	Backup timer operation	The backup timer must terminate the exposure after a time no greater than 6 seconds or after an exposure of no more than 750mAs, whichever is the lesser.	Environment Protection Authority NSW, Radiation Advisory Council Guideline #6. 2.13.1
17	Backup timer indication	A visible indication at the control panel must be provided whenever a loading has been terminated by the backup timer.	AS/NZS 3200.2.7:1994 #29.1.105(g)
18	Backup timer manual reset	When the exposure has been stopped by the backup timer it must not be possible to initiate another exposure without first operating a manual reset.	AS/NZS 3200.2.7:1994 #29.1.105(g)
19	Reproducibility	The coefficient of variation of radiation output must not exceed 0.05.	National Program for the Early Detection of Breast Cancer (1994) Appendix 4.

Test	Compliance Test	Criteria for Passing the Test	Reference
20	kVp compensation, thickness compensation	The automatic exposure control must be capable of producing consistent film density for varying breast thickness and varying kVp (both contact and magnification imaging). For phototimed images of 2, 4 and 6 centimetres of perspex using clinically relevant kVps and target/filter combinations, the variation of film optical density must not be greater than 0.15 optical density from the mean optical density.	National Program for the Early Detection of Breast Cancer (1994) Appendix 4.
Mean optical density			
21	Mean optical density	The mean optical density must not be less than 1.4 optical density. "Mean optical density" is defined as the average of the film optical densities for phototimed images of 2, 4 and 6 centimetres of perspex using clinically relevant kVps and target/filter combinations.	Australasian College of Physical Sciences and Engineering in Medicine.
Mean glandular dose			
22	Mean glandular dose	The mean glandular dose must not exceed 3mGy for a 5 centimetre breast of 50 percent adipose tissue, 50 percent glandular tissue.	National Program for the Early Detection of Breast Cancer (1994) 3.4 Technical Quality Assurance (radiation dose measurement).

Test	Compliance Test	Criteria for Passing the Test	Reference
Image quality			
23	System resolution	In contact mode: (a) Measurements made with the bars parallel to the anode-cathode axis must resolve at least 13 line pairs per millimetre; and (b) Measurements with the bars perpendicular to the anode-cathode axis must resolve at least 11line pairs per millimetre; and (c) In the magnification mode, the limiting spatial resolution must be no lower than the above specifications.	American College of Radiology (1994)
24	Object visualisation	Using an American College of Radiology accreditation phantom it must be possible to visualise: 4 of 6 fibres, 3 of 5 specks and 3 of 5 masses.	American College of Radiology (1994)

Test	Compliance Test	Criteria for Passing the Test	Reference
Protective screen			
25	Protective screen	The protective barrier: (a) Must not prevent the operator from observing the patient during the acquisition of mammograms; and (b) Must extend from not more than 15cm above the floor to a height of not less than 185 centimetres; and (c) Its width must not be smaller than 60 centimetres; and (d) It must be at least 0.3mm lead equivalence at 30 kVp.	WA Workbook 2 (7.1)

Table 2—Standard For Radiation Apparatus Used To Carry Out Intra-Oral Dental Diagnostic Radiography

Test	Compliance Test	Criteria for Passing the Test	Reference
1	Operating potential	The equipment must operate at potential differences in the range 60kVp to 90kVp.	AS/NZS 3200.2.201:1996 #29.107.1(a)
2	Reproducibility of output	The coefficient of variation of radiation output must not exceed 0.05.	AS/NZS 3200.2.201:1996 #29.104.1
3	kVp accuracy	The required kVp accuracy must be ± 5 percent or ± 5kVp whichever is the lesser of the indicated value.	AS/NZS 3200.2.201:1996 #29.104.2
4	Timer accuracy	The required exposure time accuracy must be less than ± 10 percent for exposure times greater than or equal to 0.1 seconds and less than ± 20 percent for exposure times less than 0.1 seconds.	AS/NZS 3200.2.201:1996 #29.103.1
5	Timer electronic	The exposure timer must be electronic.	AS/NZS 3200.2.201:1996 #29.103
6	Beam quality—half value layer	The total filtration must be such that the measured half-value layers are equal to or greater than 1.5mm of aluminium.	AS/NZS 3200.2.201:1996 #29.106
7	Minimum focus to skin distance	The focus to skin distance must not be less than 200 millimetres.	AS/NZS 3200.2.201:1996 #29.107.1(c)
8	Maximum dimension of X-ray field	The maximum dimension of the X-ray field at the open end of the beam applicator must not exceed 60 millimetres.	AS/NZS 3200.2.201:1996 #29.107.1(b)

Test	Compliance Test	Criteria for Passing the Test	Reference
9	Alignment open end of applicator vs X-ray field	The outline of the beam applicator must at no point be more than 3 millimetres outside the corresponding point of the X-ray field.	AS/NZS 3200.2.201:1996 #29.107.1(b)
10	Leakage radiation—X-ray source assembly	The maximum permitted leakage radiation dose rate is 0.25mGy in one hour at 1 metre with the X-ray tube operating at the maximum rated voltage and the maximum rated continuous current	AS/NZS 3200.2.201:1996 #29.105.2
11	Tube stability	The tube must remain stationary during loading.	AS/NZS 3200.2.201:1996 #29.105.4
12	Supply indicator	An indicator on the control panel, green in colour, must be visible to indicate when the main switch is in the on position and the control panel is energised.	AS/NZS 3200.2.201:1996 #29.101.3
13	Loading indicator	(a) An amber indicator, clearly visible to the operator, which indicates when the X-ray tube is energised must be provided; and (b) A signal audible to the operator, other than the sound produced by switching devices or contactors during the exposure must be provided and must indicate either the duration of the exposure or its termination.	AS/NZS 3200.2.201:1996 #29.101.4

Test	Compliance Test	Criteria for Passing the Test	Reference
14	Exposure switch position	The exposure switch must be arranged so that the X-ray equipment can be operated from a distance of at least 2 metres from the X-ray tube.	AS/NZS 3200.2.201:1996 #29.101.5
15	Exposure switch “dead-man”	The exposure time recorded must correspond to the time of actuation by the operator.	AS/NZS 3200.2.201:1996 #29.101.5

REFERENCES

AS/NZS 3200.1.3:1996	Australian /New Zealand Standard, *Approval and test specification—Medical electrical equipment—Part 1.3: General requirements for safety—Collateral Standard: Requirements for radiation protection in diagnostic X-ray equipment*.
AS/NZS 3200.2.201:1996	Australian /New Zealand Standard, *Approval and test specification—Medical electrical equipment, Part 1: Particular requirements for safety—Dento-maxillofacial X-ray equipment*.
AS 4184.2.6:1995	Standards Australia, *Evaluation and Routine Testing in Medical Imaging Departments—Part 2.6: Constancy Tests—X-ray equipment for computed tomography*, 1995.
AS/ANZ 3200.2.7:1994	Australian /New Zealand Standard *Approval and test specification—Medical electrical equipment, Part 2.7: Particular requirements for safety—High-voltage generators of diagnostic X-ray generators.*
AAPM 39	American Association of Physicists in Medicine, *Specification and acceptance testing of computed tomography scanners, AAPM Report No. 39*, 1993.
IEC 601-2-45	International Electrotechnical Commission, IEC 601-2-45, *Medical Electrical Equipment—Part 2: particular requirements for the safety of X-ray equipment for mammography (Draft)*, 1996.
NPEDBC (1994)	National Program for Early Detection of Breast Cancer, *National Accreditation Requirements, Commonwealth Department of Human Services and Health*, 1994.
NRL C5	National Radiation Laboratory, *Code of Practice for the Use of X-ray in Medical Diagnosis*, 1994.
NRPB 1996	P.C. Shrimpton, B.F. Wall, D.G. Jones, E.S. Fisher, M.C. Hillier, G.M. Kendall, *A national survey of doses to patient undergoing a selection of routine X-ray examinations in English hospitals, NRPB Report No. 200*, 1986.
NCRP 99	National Council on Radiation Protection and Measurements, *Quality assurance of diagnostic imaging equipment, NCRP Report No. 99*, Bethesda MD, 1988.
WA	Health Department of Western Australia, *Diagnostic X-ray Compliance Testing Workbook*, 1996.

Table 3—Standard For Radiation Apparatus Used To Carry Out Diagnostic Radiography Of Animals

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation output			
1	Reproducibility	The coefficient of variation of radiation output must not exceed 0.05.	WA Workbook 3 (3.5), AS/NZS 3200.2.7:1994 #50.101.1
2	Linearity	The coefficient of linearity between any two radiation output measurements must be less than or equal to 0.1.	WA Workbook 3 (3.4)
3	kVp accuracy	The required kVp accuracy must be ± 5 percent or ± 5kVp of the kVp(average), whichever is the lesser, of the indicated value.	WA Workbook 3 (3.2)
4	Timer accuracy	The required exposure time accuracy must be ± 10 percent for exposure times greater than or equal to 0.1 seconds and ± 20 percent for exposure times less than 0.1 seconds.	WA Workbook 3 (3.3), AS/NZS 3200.2.7:1994 #50.102.2
5	Beam quality—half value layer	(a) The radiation dose from a 110kVp X-ray with a 3.0 millimetre Aluminium additional filtration must be equal to or greater than half of the radiation dose without the additional filtration; and (b) The radiation dose from a 80kVp X-ray with a 2.3 millimetre Aluminium additional filtration must be equal to or greater than half of the radiation dose without the additional filtration.	AS/NZS 3200.1.3:1996 #29.201.2

Test	Compliance Test	Criteria for Passing the Test	Reference
Beam limiting device			
6	Light field intensity	The light field intensity must be greater than or equal to 100 lux.	WA Workbook 3 (2.3), AS/NZS 3200.1.3:1996 #29.202.7
7	Accuracy X-ray vs light	(a) The extent of misalignment between any boundary of the light beam and the equivalent boundary of the X-ray beam in the plane of the image receptor must not exceed 1 percent of the focus to film distance; and (b) For a 20 centimetre high test tool, the distances between the images of the test objects must not exceed 5 millimetres; and (c) For portable X-ray apparatus the extent of misalignment alignment between any boundary of the light beam and the equivalent boundary of the X-ray beam in the plane of the image receptor must not exceed 10 millimetres when using a focus to film distance of 80 centimetres.	WA Workbook 3 (2.2), AS/NZS 3200.1.3:1996 #29.202.9 Appendix ZZ

Test	Compliance Test	Criteria for Passing the Test	Reference
Leakage radiation			
8	X-ray source assembly	The leakage radiation dose rate must not exceed 1mGy in one hour at 1 metre with the X-ray tube operating at the maximum rated voltage and the maximum rated continuous current.	AS/NZS 3200.1.3:1996 #29.204.3
9	Capacitor discharge units—discharge mode	The leakage radiation dose rate from capacitor discharge units in the discharge mode must not exceed 1.0mGy in one hour.	AS/NZS 3200.1.3:1996 #29.204.4
10	Capacitor discharge units—charge and preparation modes	The leakage radiation dose rate from capacitor discharge units in the charge or preparation mode, averaged over an area of 10 square centimetres, must not exceed 20µGy in one hour.	AS/NZS 3200.1.3:1996 #29.204.5
Control panel			
11	Hand switch cord	The hand switch cord must be at least 2 metres in length.	AS/NZS 3200.1.3:1996 #29.208.1
12	More than 1 X-ray tube	If more than one X-ray tube can be operated from the same control panel, there must be a signal at the control panel indicating the X-ray tube selected. In addition there must be an indication at or near the X-ray tube selected (this may not be possible in the case of enclosed under-couch tubes).	AS/NZS 3200.2.7:1994 #29.1.103(c)

Test	Compliance Test	Criteria for Passing the Test	Reference
13	Exposure switches protected against accident actuation	All exposure switches must be protected against accidental actuation.	AS/NZS 3200.2.7:1994 #29.1.104(e)
14	Exposure switches “dead-man”	The exposure time recorded must correspond to the time of actuation by the operator.	AS/NZS 3200.2.7:1994 #29.1.104(b)
15	Loading indication	Loading in the intermittent mode, must be indicated by an amber or yellow light and an audible signal.	AS/NZS 3200.2.7:1994 #29.1.103(c)
16	Tube stability	The X-ray tube must remain stationary during loading unless it is intended to move (eg. tomography, fluoroscopy).	AS/NZS 3200.1.3:1996 #29.204.2 Appendix ZZ

Table 4—Standard for sealed radioactive substances incorporated into sealed source apparatus used to carry out industrial radiography

Test	Compliance Test	Criteria for Passing the Test	Reference
Radioactive substance details			
1	Radioactive substance certification	The radioactive substance designation must satisfy the requirements of ISO2919-1980(E) "*Sealed Radioactive Sources—Classification*" or the 'special form' design and test requirements of the International Atomic Energy Agency.	NHMRC Code of practice for the *safe use of industrial radiography equipment (1989)*, Section 2.2

Test	Compliance Test	Criteria for Passing the Test	Reference
Shutter mechanism			
2	Shutter or source control mechanism	The sealed source apparatus must be provided with a radiation source control mechanism or shutter. If power operated, the shutter or source control mechanism must be fail safe, i.e. if a power failure occurs, the return to the fully shielding condition shall be automatic. When a source control mechanism is not connected to a source container, the connection port, and for a projection type container, the projection port, must be closed with an end cap that can be screwed or otherwise firmly fixed into position, and that can be secured with a locking pin or similar device.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Sections 3.1.1, 3.1.2
3	Shutter lock	The shutter or source control mechanism must be provided with an effective key-operated lock which can be locked only when the source is in the fully shielded position, and which will secure the source in that position. The lock on the shutter must be able to resist forcible interference and resist key cylinder picking.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Sections 3.1.4, 3.1.5

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose			
4	Radiation dose rates	When the sealed source apparatus is locked in the "beam off" position, the source in the fully shielded position, and the appropriate port plugs fitted, and the largest source used is put into container the radiation dose rates must not exceed: (a) 2000µSv in one hour at any point 5 centimetres from the external surface of the sealed source apparatus; and (b) 100µSv in one hour at any point 1 metre from the external surface of the sealed source apparatus.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 3.1.7
Handling			
5	Handling features	The sealed source apparatus must be provided with a handle or handles, lifting lugs or brackets, or other means as appropriate, to facilitate safe handling.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 3.1.14

Test	Compliance Test	Criteria for Passing the Test	Reference
Labeling			
6	Labelling of containers with depleted uranium	Sealed source apparatus which incorporates depleted uranium in its construction must be durably marked with the following: • The isotope • The quantity of depleted uranium • Information on the relevant physical and radiological safety requirements	
7	Labelling	It must be durably and legibly marked with a fire resistant metal label (i.e. able to withstand 800 degrees centigrade for half of one hour), or labels, incorporating the trefoil the word "caution" and words to the general form of "radioactive material". The trefoil and markings must be black on a yellow background. A label shall also contain the following information: • Name and address of the supplier or manufacturer • Identification number of the container • The radioactive substance, its activity and the date of measurement of that activity • Maximum radiation dose rate at 1 metre from the surface of the sealed source apparatus (with shutters closed) and the date the measurement was made • Name, address and telephone number of the owner. The lettering must be black (or dark). The latter three items must be firmly fixed to the container by a metal ring or chain or other robust attachment.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 3.1.15

Test	Compliance Test	Criteria for Passing the Test	Reference
Handling equipment			
8	Guide tube	A guide tube through which the source can move freely must be provided. The end cap at the exposure end of the guide tube must be such as to prevent inadvertent release of the source when fully projected. The guide tube must be sealed to prevent ingress of material (eg. dirt, grit, moisture). The exposure end of the guide tube must be capable of being clamped in position during exposure without affecting the fee movement of the cable and source, and should be capable of being fitted with a collimator.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 3.3.1
9	Control cable	The control cable must be not less than 10 metres in length.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 3.3.3

Test	Compliance Test	Criteria for Passing the Test	Reference
10	Movement of radioactive substance	When the radioactive substance is moved pneumatically, the guide tube must have damping mechanisms at both ends to protect the source from damage. Where a source is moved by electro-mechanical or pneumatic means, a mechanical device must be provided that can be used to return the source to its container in the event of an electrical fault or electrical power failure, or pneumatic failure.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Sections 3.3.4 and 3.3.5
Additional requirements for projection-type containers			
11	Flexible source holder	A projection-type container which is designed to hold the source near the centre of a “dog-leg” or “S-bend” conduit in a shielded casing when in the fully shielded position must incorporate a flexible source holder, or pigtail, which can be secured at its cable-coupling end to the control cable port.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 3.1.6

Table 5—Standard for radiation apparatus used to carry out industrial radiography

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation output			
1	Radiation dose rates	The radiation dose rates 1 metre from the housing must not exceed 5000µSv in one hour under conditions of continuous operation at maximum energy and output.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.1
2	Radiation dose rates	X-ray equipment that is used for direct-viewing fluoroscopy must be shielded such that at no time during exposure can the radiation dose rate at any accessible position exceed 25µSv in one hour.	*Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.10
3	kVp and mA indication on control panel	The control panel must be equipped with a device or devices indicating the X-ray beam energy and output in terms of the X-ray tube potential difference (kVp) and current (mA) or electron energy and radiation dose rate, as appropriate. For equipment that is used at an open site, the values indicated must be clearly legible in bright sunlight.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.7

Test	Compliance Test	Criteria for Passing the Test	Reference
Switches			
4	Key switch on control panel	A key switch must be fitted to the X-ray control panel to prevent unauthorised use. The key must be removable only when the switch is in the off position.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.3
5	Function of key switch clearly marked	The function of the key switch and its on and off positions must be clearly marked on the control panel.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.3
6	X-ray control switch	X-ray on/off control switch must be physically separate from the key switch.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.4
7	Function of X-ray control switch	The function of the X-ray on/off control switch, and the on and off positions, must be clearly marked on the control panel.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.4
Termination of X-rays			
8	Termination of X-rays	A device must be provided which must terminate the production of X-rays after a preset interval not exceeding 30 minutes or as otherwise approved for the machine by the chief executive, in writing.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.5

Test	Compliance Test	Criteria for Passing the Test	Reference
Warning signs and lights			
9	Control panel indicator light	A red or amber indicator light must be provided on the control panel. This indicator light must be automatically illuminated when the X-ray tube is energised.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.6
10	Lamp on X-ray tube housing	A red or amber indicator lamp must be provided on the X-ray tube housing. This indicator lamp must be automatically illuminated when the X-ray tube is energised. This indicator lamp must be visible from a distance of at least 10 metres.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.6
11	Indicator lamps fail-safe	If an indicator lamp on the X-ray tube housing or on the control panel fails, the X-ray tube must not be able to be energised. Replacement of the lamp must not automatically re-energise the X-ray tube.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.6
12	Control panel fitted with remote flashing light	For open site radiography, the control panel must be fitted with a means of connecting a remote flashing light or a series of remote flashing lights which can be used to define a boundary or provide a visible warning when the equipment is energised.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.8

Test	Compliance Test	Criteria for Passing the Test	Reference
Additional requirement for equipment used at an open site			
13	Length of cable	If the X-ray equipment is used at an open site, the length of cable connecting the control panel to the X-ray tube must not be less than: • 7 metres for equipment rated at less than 100kVp • 10 metres for equipment rated at less than 200kVp • 15 metres for equipment rated at less than 250kVp • 20 metres for equipment rated at 250kVp or greater.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.1.9
Additional requirements for X-ray crawler equipment			
14	Crawler fitted with an audible alarm	Each X-ray crawler must have an audible alarm fitted to it. After the X-ray crawler has reached the exposure position, this alarm must automatically operate continuously for a warning period of 10 seconds immediately prior to the commencement of the exposure. While the exposure is taking place, the alarm must continue to emit a sound distinguishable from the 10 second warning sound.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.2.1

Test	Compliance Test	Criteria for Passing the Test	Reference
15	Accidental exposure	An X-ray crawler, for which exposures are initiated by remote control or by an automatic device such as a trip wheel, must have a safety device fitted to it which prevents the remote control or the automatic device from initiating an unintentional exposure.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.2.4.
16	Power off if malfunction occurs	An X-ray crawler must incorporate a safety device which disconnects power from the propulsion unit to the X-ray unit in the event of a malfunction during operation.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 5.2.2.5

Table 6—Standard for radiation apparatus used to carry out fluoroscopic or radiographic imaging of objects or goods

Table 6(a)—Standard for radiation apparatus used to carry out plain film radiographic imaging of inanimate objects

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation output			
1	Reproducibility	The coefficient of variation of radiation output must not exceed 0.05.	WA Workbook 3 (3.5), AS/NZS 3200.2.7:1994 #50.101.1
2	Linearity	The coefficient of linearity between any two radiation output measurements must be less than or equal to 0.1.	WA Workbook 3 (3.4)
3	kVp accuracy	The required kVp accuracy must be ± 5 percent or ± 5kVp of the kVp(average), whichever is the lesser, of the indicated value.	WA Workbook 3 (3.2)
4	Timer accuracy	The required exposure time accuracy must be ± 10 percent for exposure times greater than or equal to 0.1 seconds and ± 20 percent for exposure times less than 0.1 seconds.	WA Workbook 3 (3.3), AS/NZS 3200.2.7:1994 #50.102.2

Test	Compliance Test	Criteria for Passing the Test	Reference
5	Beam quality—half value layer	(a) The radiation dose from a 110kVp X-ray with 3.0 millimetre aluminium additional filtration must be equal to or greater than half of the radiation dose without the additional filtration; and (b) The radiation dose from a 80kVp X-ray with 2.3 millimetre aluminium additional filtration must be equal to or greater than half of the radiation dose without the additional filtration.	AS/NZS 3200.1.3:1996 #29.201.2
Beam limiting device			
6	Light field intensity	The light field intensity must be greater than or equal to 100 lux.	WA Workbook 3 (2.3), AS/NZS 3200.1.3:1996 #29.202.7

Test	Compliance Test	Criteria for Passing the Test	Reference
7	Accuracy X-ray vs light	(a) The extent of misalignment between any boundary of the light beam and the equivalent boundary of the X-ray beam in the plane of the image receptor must not exceed 1 percent of the focus to film distance; and (b) For a 20 centimetre high test tool, the distances between the images of the test objects must not exceed 5 millimetres; and (c) For portable X-ray apparatus the extent of misalignment alignment between any boundary of the light beam and the equivalent boundary of the X-ray beam in the plane of the image receptor must not exceed 10 millimetres when using a focus to film distance of 80 centimetres.	WA Workbook 3 (2.2), AS/NZS 3200.1.3:1996 #29.202.9 Appendix ZZ
Leakage radiation			
8	X-ray source assembly	The leakage radiation dose rate must not exceed 1mGy in one hour at 1 metre with the X-ray tube operating at the maximum rated voltage and the maximum rated continuous current.	AS/NZS 3200.1.3:1996 #29.204.3
9	Capacitor discharge units—discharge mode	The leakage radiation dose rate from capacitor discharge units in the discharge mode must not exceed 1.0mGy in one hour.	AS/NZS 3200.1.3:1996 #29.204.4

Test	Compliance Test	Criteria for Passing the Test	Reference
10	Capacitor discharge units—charge and preparation modes	The leakage radiation dose rate from capacitor discharge units in the charge or preparation mode, averaged over an area of 10 square centimetres, must not exceed 20μGy in one hour.	AS/NZS 3200.1.3:1996 #29.204.5
Control panel			
11	Hand switch cord	The hand switch cord must be at least 2 metres in length.	AS/NZS 3200.1.3:1996 #29.208.1
12	More than 1 X-ray tube	If more than one X-ray tube can be operated from the same control panel, there must be a signal at the control panel indicating the X-ray tube selected. In addition there must be an indication at or near the X-ray tube selected (this may not be possible in the case of enclosed under-couch tubes).	AS/NZS 3200.2.7:1994 #29.1.103(c)
13	Exposure switches protected against accident actuation	All exposure switches must be protected against accidental actuation.	AS/NZS 3200.2.7:1994 #29.1.104(e)
14	Exposure switches “dead-man”	The exposure time recorded must correspond to the time of actuation by the operator.	AS/NZS 3200.2.7:1994 #29.1.104(b)
15	Loading indication	Loading in the intermittent mode, must be indicated by an amber or yellow light and an audible signal.	AS/NZS 3200.2.7:1994 #29.1.103(c)

Test	Compliance Test	Criteria for Passing the Test	Reference
16	Tube stability	The X-ray tube must remain stationary during loading unless it is intended to move (eg. tomography, fluoroscopy).	AS/NZS 3200.1.3:1996 #29.204.2 Appendix ZZ

Table 6(b)—Standard for cabinet radiation apparatus used to carry out imaging of inanimate objects

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose			
1	Radiation dose rates	The radiation dose rate at any accessible point 5 centimetres from the external surface of the cabinet must not exceed 5μGy in one hour when averaged over an area of 100 square centimetres. Compliance with this requirement must be made with an object, typical of those examined, in the beam and any flexible or moveable screen displaced as would reasonably occur during the operation of the equipment.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 3
2	Radiation dose through conveyor system is less than 10μGy	When a conveyor system is provided, the radiation dose received by an object 20 centimetres above the conveyor must not exceed 10μGy in a single pass through the beam when the conveyor is moving at the slowest rate at which it can be operated in normal conditions.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 5.2(b)

Test	Compliance Test	Criteria for Passing the Test	Reference
Interlocks			
3	Interlocks	Where a door is provided for insertion of items to be examined or tested it must have a minimum of two safety interlocks. One interlock must be arranged to disconnect the power supply when the door is opened.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 5.1
4	Maintenance panels secured	Panels provided for maintenance purposes which could permit access to the primary beam must be so secured that tools or keys are required to open them. If a key is required, the panel must be interlocked so that when the panel is opened, the power supply is disconnected.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 5.3
5	Panel accessing X-ray tube	Any panel which allows access to the X-ray tube and is not protected by an interlock must be labelled warning of the presence of the X-ray tube.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 5.3

Test	Compliance Test	Criteria for Passing the Test	Reference
Switches			
6	Key switch on control panel	A key operated control must connected so that X-rays are not produced when the key is removed.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 6
7	X-ray control switch	An X-ray on/off control switch must be physically separate from the key switch. If a manual control, the switch must be of the "dead-man" type.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 6
Warning signs and lights			
8	X-ray indicator lights	An indicator light must be provided. This indicator light must automatically illuminated when the X-ray tube is energised. These indicator lights must be labelled "X-rays on", or words to that effect.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 8

Test	Compliance Test	Criteria for Passing the Test	Reference
9	Warning sign	A clearly visible sign bearing a trefoil and the word "caution" must be fixed to the equipment adjacent to the controls. The lettering and symbol must be in black on a yellow background.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 9
Visibility			
10	Visibility of ports and doors	For equipment designed primarily for the inspection of carry-on baggage, the operator who initiates the X-ray exposure must be in a position where s/he can readily observe all ports and doors during generation of X-rays. In the case of equipment in which the X-ray beam is activated by an automatic device, this requirement will be met by the primary viewing position for the X-ray image permitting all ports and doors to be readily observed during generation of X-rays.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 10

Test	Compliance Test	Criteria for Passing the Test	Reference
Additional requirement for radiation apparatus with entry ports			
11	Construction of equipment with entry ports	Where entry ports are provided for insertion of items or materials to be examined or tested the equipment must be so constructed so that insertion of any part of the human body into the primary beam must not be readily achieved.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 5.2(a)
Additional requirements for radiation apparatus that allows the admission of human beings			
12	X-ray control override switch	For radiation apparatus that allows human beings to be admitted to the interior for purposes associated with the operation of the equipment, there must be a control within the cabinet which can be used to terminate or prevent the production of X-rays. This control must not be able to be overridden from the outside of the cabinet.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 11(a)
13	Audible/visible signs prior to the production of X-rays	For radiation apparatus that allows human beings to be admitted to the interior for purposes associated with the operation of the equipment, there must be audible and visible signals within the cabinet activated for a least 10 seconds prior to the production of X-rays.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 11(c)

Test	Compliance Test	Criteria for Passing the Test	Reference
14	Visible signal when X-rays produced	For radiation apparatus that allows human beings to be admitted to the interior for purposes associated with the operation of the equipment, there must be a further visible warning signal within the cabinet which must be activated when X-rays are produced. If the period of exposure is intended to be less than one second, this warning signal must be activated for at least one second for each exposure.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 11(d)
15	Signs luminate when control “on”	For radiation apparatus that allows human beings to be admitted in the interior for purposes associated with the operation of the equipment, there must be clearly visible, legible signs describing the meaning of the warning signals. These signs must be adequately illuminated when the main power control is in the “on” position.	NHMRC *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes*, Section 11(e)

Table 7—Standard for sealed radioactive substances incorporated in sealed source apparatus used to carry out chemical analysis

Test	Compliance Test	Criteria for Passing the Test	Reference
Radioactive substance details			
1	Radioactive substance certification	The radioactive substance designation must have a minimum sealed source classification system of ISO/C33222, as specified in ISO2919-1980(E) "*Sealed Radioactive Sources—Classification*", or equivalent.	Final Draft, version 3.0 NHMRC *Code of practice for the safe use of elemental analysis and measurement equipment containing sealed radioactive sources*, Section 3.3
Source holder and shielding mechanism			
2	Radiation source holder securely enclosed	The radiation source holder must be securely enclosed within a shielded housing under all operational, transport or storage conditions.	Final Draft, version 3.0 NHMRC *Code of practice for the safe use of elemental analysis and measurement equipment containing sealed radioactive sources*, Section 3.3

Test	Compliance Test	Criteria for Passing the Test	Reference
3	Radiation source shielding mechanism and shutter assembly	The sealed source apparatus must be provided with a radiation source shielding mechanism and a shutter assembly.	Final Draft, version 3.0 NHMRC *Code of practice for the safe use of elemental analysis and measurement equipment containing sealed radioactive sources*, Section 3.3
4	Shutter assembly interlock	The shutter assembly must be interlocked such that the aperture will not be in the open position when the sample or sample holder is not placed in the correct or appropriate position.	Final Draft, version 3.0 NHMRC *Code of practice for the safe use of elemental analysis and measurement equipment containing sealed radioactive sources*, Section 3.3

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose			
5	Radiation dose rates	When the sealed source apparatus is locked in the "beam off" position, the radiation dose rates must not exceed: (a) 10µSv in one hour at any point 5 centimetres from the external surface of the sealed source apparatus; and (b) 1µSv in one hour at any point 1 metre from the external surface of the sealed source apparatus.	Final Draft, version 3.0 NHMRC *Code of practice for the safe use of elemental analysis and measurement equipment containing sealed radioactive sources*, Section 3.4
6	Interception of primary radiation beam	Primary radiation emitted by the radioactive substance must be stopped by an effective shutter assembly (or equivalent) at all times except during a measurement.	Final Draft, version 3.0 NHMRC *Code of practice for the safe use of elemental analysis and measurement equipment containing sealed radioactive sources*, Section 3.3

Test	Compliance Test	Criteria for Passing the Test	Reference
Warning signs			
7	Shutter operation indicators	Visible and/or audible indicators must signal the imminent or actual opening of the shutter.	Final Draft, version 3.0 NHMRC *Code of practice for the safe use of elemental analysis and measurement equipment containing sealed radioactive sources*, Section 3.3

Test	Compliance Test	Criteria for Passing the Test	Reference
8	Labels relating to the sealed source apparatus	The type, manufacturer, model number and serial number details of the sealed source apparatus must be visible and affixed to an external surface. This label must also display words to the effect of: • Removal of the label is prohibited. • This label must be maintained on the device in a legible condition. • Installation, dismantling, maintenance, repair and testing involving the radioactive material, its shielding or containment must only be performed by authorised persons. • The device must be tested for radiation emission and proper function of the safety mechanisms and indicator (if any) installation, at source replacement, repairs and thereafter at intervals no longer than one year. • Loss or theft of this device and failure or damage to the shielding, the source containment or any of the safety features shall be reported immediately to the radiation safety officer. The label(s) must be durable, clearly visible to the operator and of a size such that the wording is legible. The lettering must be black (or dark).	Final Draft, version 3.0 NHMRC *Code of practice for the safe use of elemental analysis and measurement equipment containing sealed radioactive sources*, Section 3.3

Test	Compliance Test	Criteria for Passing the Test	Reference
9	Labels relating to the radioactive substance	A label must be present for each radioactive substance installed in the sealed source apparatus and must be affixed to a visible external surface as close as possible to the source location. Each label must incorporate the following: • a trefoil • words “caution—radioactive material” • the manufacturer of radioactive substance • the model and serial number of the radioactive substance • the name of the radionuclide or the radioactive substance type e.g. Am241/Be • the date of manufacture of the sealed source apparatus • the activity of the radioactive substance • the date the activity was measured • the maximum activity permitted in the sealed source apparatus for each radioactive substance The label(s) must be durable, clearly visible to the operator and of a size such that the wording is legible. The background of the warning label containing (a) and (b) must be yellow with markings and trefoil in black. All other lettering must be black (or dark).	Final Draft, version 3.0 NHMRC *Code of practice for the safe use of elemental analysis and measurement equipment containing sealed radioactive sources*, Section 3.3

Test	Compliance Test	Criteria for Passing the Test	Reference
Additional requirement for sealed source apparatus with external probes			
10	Shutter assembly operation	For sealed source apparatus with external probes containing sealed radioactive substances, and where the sample is external to the device: (a) The shutter assembly actuator must be designed to avoid inadvertent opening of the shutter by accident. In the event of power failure to the device, a fail-safe shutter mechanism must prevent the shutter from remaining open; or (b) A fail-safe, automatically activated shutter mechanism must be installed which opens the shutter only when placed against the sample.	Final Draft, version 3.0 NHMRC *Code of practice for the safe use of elemental analysis and measurement equipment containing sealed radioactive sources*, Section 3.3

Table 8—Standard for radiation apparatus used to carry out chemical analysis

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose rate			
1	Radiation dose rates around tube housing	The radiation dose rate at any accessible point 5 centimetres from the surface of the tube housing, including the closed shutter or enclosure over each aperture in the housing, must not exceed 25µGy in one hour when the X-ray tube is operated at any of the permissible ratings specified by the manufacturer of the X-ray analysis unit.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.2.3
2	Radiation dose rates around tube shutter	Each tube shutter must be so constructed that the scattered and leakage radiation dose in one hour at any accessible point 5 centimetres from the shutter does not exceed 25µGy in one hour when the X-ray tube is operated at any of the permissible ratings specified by the manufacturer of the X-ray analysis unit.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.3.1
3	Radiation dose rates behind beam stop	The radiation dose rates behind the beam stop in the line of the primary beam from the aperture during all normal operations must be less than 25µGy in one hour at any accessible point 5 centimetres from the beam stop when the X-ray tube is operated at any of the permissible ratings specified by the manufacturer of the X-ray analysis unit.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.5

Test	Compliance Test	Criteria for Passing the Test	Reference
Tube housing			
4	X-ray tube enclosed in a tube housing	Each X-ray tube must be enclosed in a tube housing.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.2
5	Each aperture in tube housing covered	Each aperture in the tube housing must be covered by one of the following: (a) A shutter, or (b) A completely shielded enclosure, with all entrances interlocked to prevent the tube being energised.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.2.2
6	X-ray tube and tube housing interlocked	The X-ray tube and tube housing must be interlocked so that the removal of one from the other or the removal of protective covers from any port or service opening will immediately switch off the X-ray tube.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.2.4

Test	Compliance Test	Criteria for Passing the Test	Reference
7	Detachment of enclosure covering the aperture	Each enclosure covering the aperture in the tube housing must comply with one of the following: (a) Be attached to the tube housing so that it can only be detached by using tools; or (b) Be interlocked with the tube housing so that detachment of the enclosure from the housing de-energises the X-ray tube; or (c) Be attached to the tube housing so that detachment of the enclosure immediately closes the relevant aperture shutters.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.4
Shutter			
8	Shutter fitted with a positive closing device	Each tube shutter must be fitted with a positive closing device which, in the absence of an external applied force, keeps the shutter closed.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.3.2
9	Removal of shutter and operating mechanism	Each tube shutter must be constructed so that it is impossible to remove the shutter and its operating mechanism without the use of tools.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.3.3

Test	Compliance Test	Criteria for Passing the Test	Reference
10	Shutter and operating mechanism interlocked	Each tube shutter must be constructed so that the shutter and its operating mechanism are interlocked with the tube housing so that their removal switches off the X-ray tube.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.3.4
Beam stops			
11	Beam stops located close to apertures	One or more beam stops must be placed as close as practicable to each aperture of the X-ray tube housing.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.5
Additional requirements for an enclosed radiation apparatus			
12	Beam stop interlocked	For an enclosed unit, each beam stop must form a fixed part of the unit, removable only by the use of tools. Each beam stop must be interlocked so that removal of the beam stop: (a) De-energises the X-ray tube; or (b) Immediately closes the shutter related to that beam stop.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.5

Test	Compliance Test	Criteria for Passing the Test	Reference
13	Shutter mechanism over-lapping the collimator	At each aperture in the tube housing of an enclosed unit which is fitted with a shutter, the shutter mechanism must incorporate permanent shielding in the form of a sleeve overlapping the collimator.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.4.5
Warning signs/lights			
14	Indicator lights	The equipment must be fitted with an illuminated sign or combination of a sign and a light which is activated only if the X-ray tube is energised and which then indicates that the X-ray tube is operating. This light must be either red or orange. The illuminated sign must be legible and readily discernible for at least 2 metres on all accessible sides of the equipment.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.6.1 and 5.3.6.5
15	Shutter sign or light	Each shutter must be linked with an illuminated sign or light which is illuminated only when that shutter is open and indicates without ambiguity which shutter is open. This light must be either red or orange.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.6.2 and 5.3.6.5

Test	Compliance Test	Criteria for Passing the Test	Reference
16	Lights fail safe	The warning lights must be fail safe (ie. to de-energize the X-ray tube if a light fails), or adequate warning that a light has failed must be indicated in a clear and unambiguous manner.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.6.6
17	Type of unit labelled	Radiation apparatus must be clearly labelled to indicate whether it is an enclosed unit or a partly enclosed unit.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.6.9
18	Warning if barriers or shields incomplete	Partly enclosed units which incorporate fixed shielding and/or barriers must be designed to give a clear and positive warning if the barriers or shields are incomplete.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.6.7

Table 9—Standard for sealed radioactive substances incorporated in sealed source apparatus used to carry out industrial gauging

Test	Compliance Test	Criteria for Passing the Test	Reference
Radioactive substance details			
1	Radioactive substance certification	The radioactive substance designation must satisfy the requirements of ISO2919-1980(E) "*Sealed Radioactive Sources—Classification*" or the 'special form' design and test requirements of the International Atomic Energy Agency.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 2.2
Shutter mechanism			
2	Shutter or source control mechanism	The sealed source apparatus must be provided with a radiation source control mechanism or shutter. This shutter or source control mechanism must be fail safe.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.1
3	Shutter lock	The shutter must be provided with an effective lock so that it can be secured in the "beam off" position. The shutter must not be able to be locked in the "beam on" position. The lock on the shutter must be able to resist forcible interference and resist key cylinder picking.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.1

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose			
4	Radiation dose rates	When the sealed source apparatus is locked in the "beam off" position, the radiation dose rates must not exceed: (a) 300µSv in one hour at any point 5 centimetres from the external surface of the sealed source apparatus; and (b) 10uSv in one hour at any point 1 metre from the external surface of the sealed source apparatus.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.1
Handling			
5	Handling features	The sealed source apparatus must be provided with means for manual handling if it has a gross mass between 10 kilograms and 50 kilograms. The radiation apparatus must have features to enable safe handling by mechanical means if it has a gross mass over 50 kilograms.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.1

Test	Compliance Test	Criteria for Passing the Test	Reference
Labelling			
6	Labelling of indicators	The "beam on" and "beam off" positions must be clearly and unambiguously indicated. The indicator must be protected against mechanical damage. If a mechanical indicator is used, the "beam on" and "beam off" markings shall be of a type that can withstand temperatures of 800 degrees centigrade for half of one hour and which cannot be readily obscured by dust, precipitation, corrosion or paint. If an electrical indicator is used, it must include separate lamps or signals to indicate the "beam on" and "beam off" conditions and must be fail safe.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.1
7	Labelling of containers with depleted uranium	Sealed source apparatus which incorporates depleted uranium in its construction must be durably marked with the following: • The radionuclide • The quantity of depleted uranium • Information on the relevant physical and radiological safety requirements	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3

Test	Compliance Test	Criteria for Passing the Test	Reference
8	Labelling	It must be durably and legibly marked with a metal label incorporating the trefoil, the word "caution" and words to the effect of "radiation source". The trefoil and markings must be engraved or embossed and must be black on a yellow background. The metal label must also be able to withstand 800 degrees centigrade for half of one hour. A label must also contain the following information: • Manufacturer name, model and serial number of the sealed source apparatus • Name and address of the radioactive substance supplier and manufacturer • Name of the radioactive substance • Model and serial number of the radioactive substance • ISO classification number of the radioactive substance • Original activity of the radioactive substance and the date that this activity was measured • Working life expiry date of the radioactive substance • Maximum radiation dose rate at 1 metre from the surface of the sealed source apparatus (with shutters closed) and the date the measurement was made. The lettering must be black (or dark).	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.1

Table 10—Standard for radiation apparatus used to carry out industrial gauging

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose			
1	Radiation dose rates	When the X-ray tube assembly is energised, operating at its maximum output and with the shutter closed, the radiation dose rate must not exceed 300µSv in one hour at any accessible point 5 centimetres from the external surface of the tube housing or shielded enclosure, and 10µSv in one hour at any point one metre from the surface of the tube housing or shielded enclosure.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.2
Shutter mechanism			
2	Shutter available	A shutter must be fitted to the tube housing unless a specific approval has been given for the specific machine, in writing, by the chief executive.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.2
3	Shutter or source control mechanism	A shutter or source control mechanism must be manually operated or power operated, and must be fail safe.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.2

Test	Compliance Test	Criteria for Passing the Test	Reference
4	Shutter lock	The shutter, if fitted to the tube housing, must be provided with an effective lock so that it can be secured in the "beam off" position. The lock on the shutter must be able to resist forcible interference and resist key cylinder picking.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.2
Interlocks			
5	Interlocks	If primary shielding is provided by a shielded enclosure, interlocks must be fitted to the enclosure to switch off the X-ray tube if the enclosure is opened. If primary shielding is provided by both tube housing and shielded enclosure, the design of the gauge must use tube housing shutters and/or interlocks to prevent access to the primary beam.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.2
6	Panels secured	Panels, provided for maintenance access or other purposes, which could permit access to the primary beam must be: (a) secured so that tools or keys are required to open them; and (b) provided with at least one safety interlock and a label that warns of the presence of an X-ray tube within.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.2

Test	Compliance Test	Criteria for Passing the Test	Reference
Handling			
7	Handling features	The radiation apparatus must be provided with means for manual handling if it has a gross mass between 10 kilograms and 50 kilograms. The radiation apparatus must have features to enable safe handling by mechanical means if it has a gross mass over 50 kilograms.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.2
Warning signs/labels			
8	Indicators	Whenever the shutter or source control mechanism is in either the “beam on” or “beam off” position, that condition must be clearly and unambiguously indicated. If a mechanical indicator is used, the indicator cannot readily be obscured by dust, corrosion or paint. If an electrical indicator is used, it shall include separate lamps or signals to indicate the “beam on” and “beam off” conditions, and shall be designed to be fail safe in the event of a lamp failure.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.2

Test	Compliance Test	Criteria for Passing the Test	Reference
9	Labelling	The apparatus must be durably marked with a fire-resistant label incorporating the trefoil the words “caution” and words to the general form of “radiation source”. A label must also contain the following information: • Manufacturer name, model and serial number of the radiation gauge, tube housing and/or shielded enclosure • Manufacturer name, model and serial number of the tube insert • Maximum rated tube potential (kVp) • position of the focal spot • maximum radiation dose rate at 1 metre from the surface of the tube housing or shielded enclosure (with all shutters closed) and the date this measurement was made Labels must be legible.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges*, Section 3.2

Table 11—Standard for sealed radioactive substances incorporated in sealed source apparatus used to carry out borehole logging

Test	Compliance Test	Criteria for Passing the Test	Reference
Radioactive substance details			
1	Radioactive substance certification	The radioactive substance designation must satisfy the requirements of ISO2919-1980(E) "*Sealed Radioactive Sources—Classification*" or the 'special form' design and test requirements of the International Atomic Energy Agency.	NHMRC *Code of Practice for the safe use of sealed radioactive sources in borehole logging (1989)*, Section 3.2.1
2	Radioactive substance fixed in sealed source apparatus	The radioactive substance must be fixed and locked in the sealed source apparatus in such a manner to prevent loss, dislodgment or removal of the source by unauthorised person.	NHMRC *Code of Practice for the safe use of sealed radioactive sources in borehole logging (1989)*, Section 3.3.2
3	Positively located	The radioactive substance must be positively located in the sealed source apparatus to allow "hands off" attachment and detachment of spacers and/or tool.	NHMRC *Code of Practice for the safe use of sealed radioactive sources in borehole logging (1989)*, Section 3.3.5
Shielding material			
4	Shielding material	The sealed source apparatus must be constructed of fire resistant materials. If non-fire resistant material is used (eg. paraffin, wax, etc.), it must be enclosed in a fire resistant vessel which will prevent the loss of the shielding material in the event of fire.	NHMRC *Code of Practice for the safe use of sealed radioactive sources in borehole logging (1989)*, Section 3.4.3

Test	Compliance Test	Criteria for Passing the Test	Reference
Tool			
5	Mechanism for attaching the sealed radioactive substance holder to the tool	The mechanism for attaching the source holder or subassembly containing the sealed radioactive substance holder to the tool must not result in unintentional release of the tool.	NHMRC *Code of Practice for the safe use of sealed radioactive sources in borehole logging (1989)*, Section 3.3.4
Radiation dose			
6	Radiation dose rates	When the radioactive substances are locked in the sealed source apparatus, the radiation dose rates must not exceed: (a) 2000µSv in one hour at any point 5 centimetres from the external surface of the sealed source apparatus; and (b) 100µSv in one hour at any point 1 metre from the external surface of the sealed source apparatus.	NHMRC *Code of Practice for the safe use of sealed radioactive sources in borehole logging (1989)*, Section 3.4.1

Test	Compliance Test	Criteria for Passing the Test	Reference
Labelling			
7	Labelling	The sealed source apparatus must be durably and legibly marked with a fire resistant label (able to withstand 800 degrees centigrade for half of one hour), or labels, incorporating the trefoil the word "caution" and words to the general form of "radioactive material". The trefoil and markings must be black on a yellow background. A label shall also contain the following information: • Name and address of the supplier or manufacturer • Identification number of the container • The radioactive substance, its activity and the date of measurement of that activity • Maximum radiation dose rate at 1 metre from the surface of the sealed source apparatus (with shutters closed) and the date the measurement was made • Name, address and telephone number of the owner.	NHMRC *Code of Practice for the safe use of sealed radioactive sources in borehole logging (1989)*, Section 3.3.7

Table 12—Standard for sealed radioactive substances incorporated in sealed source apparatus used to carry out moisture/density measurements

Test	Compliance Test	Criteria for Passing the Test	Reference
Radioactive substance details			
1	Radioactive substance certification	The radioactive substance designation must satisfy the requirements of ISO2919-1980(E) "*Sealed Radioactive Sources—Classification*" or the 'special form' design and test requirements of the International Atomic Energy Agency.	NHMRC *Code of practice for the safe use of soil density and moisture gauges containing radioactive sources (1984)*, Section 3.2.1
2	Sealed radioactive substance fixed in sealed source apparatus	The radioactive substances must be permanently mounted in the sealed source apparatus and capable of extension and retraction for normal use. The radioactive substance must not be capable of being physically separated from the sealed source apparatus under operational and transport conditions.	NHMRC *Code of practice for the safe use of soil density and moisture gauges containing radioactive sources (1984)*, Section 3.3.1
3	Radioactive substance assembly	The radioactive substance assembly must be capable of being positively located in the correct operating positions.	NHMRC *Code of practice for the safe use of soil density and moisture gauges containing radioactive sources (1984)*, Section 3.3.7

Test	Compliance Test	Criteria for Passing the Test	Reference
Shutter mechanism			
4	Locked in position	The radioactive substances must be able to be locked in the "beam off" position. This locking device must be an integral part of the sealed source apparatus.	NHMRC *Code of practice for the safe use of soil density and moisture gauges containing radioactive sources (1984)*, Section 3.3.6
Radiation dose			
5	Radiation dose rates	When the radioactive substances are locked in the "beam off" position, the radiation dose rates must not exceed: (a) 500µSv in one hour at any point 5 centimetres from the external surface of the sealed source apparatus; and (b) 10µSv in one hour at any point 1 metre from the external surface of the sealed source apparatus.	NHMRC *Code of practice for the safe use of soil density and moisture gauges containing radioactive sources (1984)*, Section 3.4.1

Test	Compliance Test	Criteria for Passing the Test	Reference
Labelling			
6	Labelling	The external surface of the sealed source apparatus must be durably and legibly marked with a fire resistant label, or labels, incorporating the trefoil the word "caution" and words to the general form of "radioactive material". The trefoil and markings must be black on a yellow background. A label shall also contain the following information: • Name and address of the supplier or manufacturer • Identification number of the container • The radioactive substance, its activity and the date of measurement of that activity • Maximum radiation dose rate at 1 metre from the surface of the sealed source apparatus (with shutters closed) and the date the measurement was made • Name, address and telephone number of the owner.	NHMRC *Code of practice for the safe use of soil density and moisture gauges containing radioactive sources (1984)*, Section 3.3.11

Table 13—Standard for premises at which radiation apparatus is used to carry out health related diagnostic radiography or radiation therapy

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose			
1	Radiation dose	The radiation dose rate in and around the premises must not exceed the following: Public Areas 10μSv in one week Occupational Areas—Supervised 10μSv in one week Occupational Areas—Controlled 40μSv in one week	*Radiation Shielding Manual*, May 1997
Communication			
2	Communication with patients	The operator in the control area must be able to view and communicate with a patient undergoing the radiation procedure.	NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV*, Section 6.1.6

Test	Compliance Test	Criteria for Passing the Test	Reference
Warning labels			
3	Radiation warning signs	All public entrances must be labelled with radiation warning signs consisting of a radiation warning sign (trefoil) and words to the effect of "warning: radiation area". For dental premises where radiology is not the prime purpose of the room, the sign may have words to the effect of "warning: X-rays are used in this area". The word "caution" is also acceptable. The symbol, lettering and border must be black on a yellow background.	Australian Standard AS 1319-1994 *Safety signs for the occupational environment*, Table B3
4	Pregnancy signs	Pregnancy signs must be displayed in conspicuous locations. The sign is to be a multilingual notice with words to the effect of: "If you are pregnant or think that you might be pregnant notify the radiographer before the X-ray examination commences" This requirement does not apply to dental practices.	NHMRC *Recommendations for Minimising Radiological Hazards to Patients (1985)*

Test	Compliance Test	Criteria for Passing the Test	Reference
Additional requirement for a CT or fixed fluoroscopy room			
5	Illuminated radiation warning signs	An illuminated radiation warning sign must be provided at each public entrance. Each sign is wired in such a way that ensures it is illuminated during both preparation time and the full period of the X-ray exposure.	Australian Standard AS2814-1985 *Diagnostic X-ray Facilities—Safe Practices*, Section 3.2.7
Additional requirements for a therapy room			
6	Radiation warning signs	An illuminated radiation warning sign must be provided at every access door. Each sign is wired in such a way that it is illuminated during both preparation time and full period of the X-ray exposure.	NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV,* Section 6.1.5 NCRP Report No. 51 *Radiation Protection Design Guidelines for 0.1—100 MeV Particle Accelerator Facilities* Sections 2.2.2 and 2.2.3

Test	Compliance Test	Criteria for Passing the Test	Reference
7	Interlocks	All doors must be interlocked to ensure that exposures cannot be made if any door is open. The opening of an interlocked door during exposure must automatically cause the interruption of the power supply to the radiation apparatus, and subsequent closure of this interlocked door must not automatically re-energise the radiation apparatus.	NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV*, Section 6.1.5 NCRP Report No. 51 *Radiation Protection Design Guidelines for 0.1—100 MeV Particle Accelerator Facilities*, Sections 2.2.2 and 2.2.3
Additional facility requirements for a therapy room containing radiation apparatus producing X-rays > 0.1 MeV			
8	Primary beam restriction	The useful beam must not be able to strike secondary protective barriers.	NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV*, Section 6.3

Test	Compliance Test	Criteria for Passing the Test	Reference
9	Emergency off switch	An emergency “off” switch which terminates an exposure must be provided in the treatment room.	NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV,* Section 6.3 NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV,* Section 6.1.5

Table 14—Standard for premises at which radiation apparatus is used to carry out veterinary diagnostic radiography or radiation therapy

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose			
1	Radiation dose	The radiation dose rate in and around the premises must not exceed the following: Public Areas 10μSv in one week Occupational Areas—Supervised 10μSv in one week Occupational Areas—Controlled 40μSv in one week	*Radiation Shielding Manual*, May 1997
Warning labels			
2	Radiation warning signs	All public entrances must be labelled with radiation warning signs consist of a trefoil symbol and words to the effect of "warning: radiation area". The word "caution" is also acceptable. The symbol, lettering and border must be black on a yellow background.	Australian Standard AS 1319-1994 *Safety signs for the occupational environment*, Table B3

Test	Compliance Test	Criteria for Passing the Test	Reference
Additional requirement for a CT or fixed fluoroscopy room			
3	Illuminated radiation warning signs	An illuminated radiation warning sign must be provided at each public entrance. Each sign is wired in such a way that ensures it is illuminated during both preparation time and the full period of the X-ray exposure.	Australian Standard AS2814-1985 *Diagnostic X-ray Facilities—Safe Practices*, Section 3.2.7
Additional requirements for a therapy room			
4	Radiation warning signs	An illuminated radiation warning sign must be provided at every access door. Each sign is wired in such a way that it is illuminated during both preparation time and full period of the X-ray exposure.	NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV*, Section 6.1.5 NCRP Report No. 51 *Radiation Protection Design Guidelines for 0.1—100 MeV Particle Accelerator Facilities*, Sections 2.2.2 & 2.2.3

Test	Compliance Test	Criteria for Passing the Test	Reference
5	Interlocks	All doors must be interlocked to ensure that exposures cannot be made if any door is open. The opening of an interlocked door during exposure must automatically cause the interruption of the power supply to the radiation apparatus, and subsequent closure of this interlocked door must not automatically re-energise the radiation apparatus.	NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV*, Section 6.1.5 NCRP Report No. 51 *Radiation Protection Design Guidelines for 0.1—100 MeV Particle Accelerator Facilities* Sections 2.2.2 & 2.2.3
Additional requirements for a therapy room containing radiation apparatus producing X-rays > 0.1 MeV			
6	Primary beam restriction	The useful beam must not be able to strike secondary protective barriers.	NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV*, Section 6.3
7	Emergency off switch	An emergency off switch, which terminates an exposure, must be provided in the treatment room.	NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV* Section 6.3 NCRP Report No.49 *Structural Shielding Design and Evaluation for Medical use of X-rays and Gamma Rays of Energies up to 10 MeV*, Section 6.1.5

Table 15—Standard for premises at which radioactive substances are used to carry out a radiation practice

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose rate			
1	Radiation dose rate	The radiation dose rate in and around the premises must not exceed the following: Public Areas 10µSv in one week Occupational Areas—Supervised 10µSv in one week Occupational Areas—Controlled 40µSv in one week	*Radiation Shielding Manual*, Queensland Health, May 1997
Warning labels			
2	Radiation warning signs	All public entrances must be labelled with radiation warning signs consisting of a radiation warning sign (trefoil) and words to the general form of "warning: radiation area". The symbol, lettering and border must be black on a yellow background.	Australian Standard AS 1319-1994 *Safety signs for the occupational environment*, Table B3 Australian Standard AS2243.4—1998, *Safety in laboratories, Part 4: Ionizing radiations*, Section 6.3, 6.5.1 & 6.6
3	After hours contact information displayed	The after hours contact telephone number must be displayed at all premises.	Australian Standard AS2243.4—1998—*Safety in laboratories, Part 4: Ionizing radiations*, Section 11.5.8

Test	Compliance Test	Criteria for Passing the Test	Reference
Additional labelling requirements for health related applications			
4	Pregnancy signs	Pregnancy signs must be displayed in conspicuous locations. Each sign is to be a multi-lingual notice with words to the effect of: "If you are pregnant or think that you might be pregnant notify the doctor before the radiation procedure commences"	NHMRC *Recommendations for Minimising Radiological Hazards to Patients (1985)*
Additional requirements for unsealed radioactive substances			
5	Surface finishes	The floor, walls, ceilings, bench tops, sinks and furniture in the premises must be smooth, non absorbent, decontaminable continuous surfaces. Joins between bench surfaces must be constructed so that they do not leak or trap radioactive contamination.	NHMRC *Code of Practice for the Design of Laboratories using Radioactive Substances for Medical Purposes*, Section 4 Australian Standard AS2243.4—1998, *Safety in laboratories, Part 4: Ionizing radiations*, Section 11.6 and Table 11.2

Test	Compliance Test	Criteria for Passing the Test	Reference
6	Benches	Benches must have a smooth water proof, chemically resistant covering which is easy to clean. The bench top must also be able to support the weight of any shielding likely to be used thereon. The front and side edges of the bench top must be slightly raised and the back coved up to the wall or reagent shelf, so that the bench top acts as a shallow tray to help contain spills.	Australian Standard AS2243.4—1998, *Safety in laboratories, Part 4: Ionizing radiations*, Section 11.6
7	Hand basins	Taps for hand washbasins must be able to be operated by wrist, knee or foot.	Australian Standard AS2243.4—1998, *Safety in laboratories, Part 4: Ionizing radiations*, Section 11.6
8	Drainage systems	Drainage systems within the premises in which the practice is to be carried out must be arranged so that other building areas cannot become contaminated if the drainage system becomes blocked. It must also be continuous and appropriately labelled at accessible locations.	Australian Standard AS2243.4—1998, *Safety in laboratories, Part 4: Ionizing radiations*, Section 11.6
9	Storage cupboards	Secure storage facilities must be provided for the storage of radionuclides. Shielding must be provided as appropriate.	Australian Standard AS2243.4—1998, *Safety in laboratories, Part 4: Ionizing radiations*, Section 11.6

Test	Compliance Test	Criteria for Passing the Test	Reference
10	Ventilation	Air from the premises must not be recirculated into the general ventilation system. Depending upon the radionuclides and the nature of use, the minimum outdoor fresh air flow rate per unit of total floor area must range between 3 to 9 litres per second per square metre as follows: Low level radioisotope laboratory — 3—6 litres per second per square metre of total floor area Medium level radioisotope laboratory — 6—9 litres per second per square metre of total floor area	NHMRC *Code of Practice for the Design of Laboratories using Radioactive Substances for Medical Purposes*, Section 5.1.5 Australian Standard AS2243.4—1998, *Safety in laboratories, Part 4: Ionizing radiations*, Section 11.6 and tables 11.1 and 11.2.

Table 16—Standard for premises where radiation sources are used to carry out industrial radiography, excluding open sites.

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose rate			
1	Radiation dose rate	The radiation dose rate in and around the premises must not exceed the following: Public Areas 10µSv in one week Occupational Areas—Supervised 10µSv in one week Occupational Areas—Controlled 40µSv in one week In addition, the instantaneous dose rate 5 centimetres from the outer surface of the premises must not exceed 25µSv per hour.	*Radiation Shielding Manual*, Queensland Health, May 1997
2	Access aperture coverings overlap	Doors and panels covering access apertures must overlap those apertures by a margin sufficient to prevent the leakage of scattered radiation from the enclosure.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 6.1.6 and 6.2.6

Test	Compliance Test	Criteria for Passing the Test	Reference
3	Radiation shielding integrity not impaired	Conduits for feeding cabling, including windout cables, electrical power or other services through the walls, must incorporate a dog-leg or baffle that leaves no line-of-sight aperture through the walls to the radiation source, so that the radiation shielding integrity of the walls is not impaired.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 6.1.7 and 6.2.8
Operation			
4	Operation via remote control	The radiography equipment must be operated from outside by remote control.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 6.1 and 6.2
Warning signs and lights			
5	Warning signs	A fully enclosed site and a partially enclosed site must be clearly identified as such through the use of warning notices at access points.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 6.1.3 and 6.2.2

Test	Compliance Test	Criteria for Passing the Test	Reference
6	Visible / audible warning lights provided	A warning light or lights must illuminate during exposure and be clearly visible from outside the enclosure. A fully enclosed site must be provided with visible and audible warning devices inside the enclosure which must activate during exposure. A partially enclosed site must be provided with visible and audible warning devices which must be activated during exposure and which can be seen and heard from both inside and outside the enclosure.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 6.2.2, 6.1.3 and 6.1.5

Test	Compliance Test	Criteria for Passing the Test	Reference
Interlocks at access points			
7	Interlocks at access points	All entrances or exits used to permit the access of persons to or from the exposure bay must incorporate a lockable door or barrier interlocked to ensure the following occur. Visible and audible alarms must activate if any interlock is opened during an exposure. In the case of radiation apparatus, the opening of an interlocked door during exposure must automatically cause the interruption of the power supply to the radiation apparatus, and subsequent closure of this interlocked door must not automatically re-energise the radiation apparatus.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 6.1.4, 6.1.5, 6.2.5
Exit from enclosure			
8	Able to exit from within enclosure	A suitable means of exit, which may be the main or only exit, must be provided to enable any person who is accidentally shut in to leave the enclosure without delay. The exit must be interlocked. Opening of this exit during exposure must activate a visible and audible alarm and must automatically cause the interruption of the power supply to the radiation apparatus. Subsequent closing of the exit must not automatically reset the alarm or re-energise the radiation apparatus.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 6.1.5

Test	Compliance Test	Criteria for Passing the Test	Reference
Additional requirements for a fully enclosed site			
9	Completely shielded enclosure	When access doors or ports are closed, the walls, floor and ceiling of the site must form a complete shielding enclosure.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 6.1.1
Additional requirements for a partially enclosed site			
10	Wall height	A partially enclosed site must be constructed with walls at least 2.1 metres high.	NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 6.2.1

Table 17—Standard where premises at which radiation apparatus is used to carry out chemical analysis

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose			
1	Radiation dose	The radiation dose rate in and around the premises must not exceed the following: Public Areas 10µSv in one week Occupational Areas – Supervised 10µSv in one week Occupational Areas— Controlled 40µSv in one week	*Radiation Shielding Manual*, May 1997
Warning labels			
2	Sign at each entrance	Premises must have a sign at each entrance stating that a radiation apparatus is located in the premises.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.6.3 and 5.3.6.5
3	Lights fail safe	All warning lights must be fail safe (ie. to de-energise the X-ray if a light fails), or adequate warning that a light has failed must be indicated in a clear and unambiguous manner.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.6.6

Test	Compliance Test	Criteria for Passing the Test	Reference
Additional requirements for a partly enclosed unit			
4	Entrance sign illuminated if tube energised	Premises must have at each entrance an illuminated sign or a sign combined with a light which is activated only when the X-ray tube is energised and which indicates that the X-ray tube is operating.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.6.4 and 5.3.6.5
5	Notice displayed about hazards	A clear and unambiguous notice must be displayed on or near a partly enclosed unit indicating the hazards of operating the unit while barriers or shields are incomplete. Partly enclosed units which are enclosed by interlocked or fixed barriers and/or shields must have displayed on or near them a prominent notice which warns of the hazard of placing any part of the body, such as the hand, inside the barriers or shields.	NHMRC *Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)*, Section 5.3.6.8

Table 18—Standard for premises at which radiation sources are used to carry out industrial gauging

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose rate			
1	Radiation dose rate	The radiation dose rate in and around the premises must not exceed the following: Public Areas 10µSv in one week Occupational Areas—Supervised 10µSv in one week Occupational Areas—Controlled 40µSv in one week	*Radiation Shielding Manual*, Queensland Health, May 1997

Test	Compliance Test	Criteria for Passing the Test	Reference
Warning labels			
2	Radiation warning signs	A sign must be displayed in a conspicuous location adjacent to the radiation source which contains the following information: • Radiation warning sign (trefoil) • The word "caution" or "warning" • Words to the general form of "fixed radiation gauge containing radiation source" The symbol and lettering must be black on a yellow background. This sign must be clean, intact and in a legible condition.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges (1998)*, Section 4.4.23
Installations on continuous moving lines			
3	Installations on continuous moving lines	Radiation sources installed on continuously moving lines must be interlocked so that, when the line is stopped, the shutter will close, the radioactive substance will move to the "beam off" position or the X-ray tube will de-energise, as appropriate.	Draft, January 1998, NHMRC *Code of practice for the safe use of fixed radiation gauges (1998)*, Section 4.4.3

Table 19—Standard for premises at which radioactive substances are stored

Test	Compliance Test	Criteria for Passing the Test	Reference
Radiation dose rate			
1	Radiation dose rate	The radiation dose rate in and around the premises must not exceed the following: Public Areas 10µSv in one week Occupational Areas— Supervised 10µSv in one week Occupational Areas— Controlled 40µSv in one week In addition, the instantaneous dose rate 5 centimetres from the outer surface of the premises must not exceed 25 µSv per hour.	*Radiation Shielding Manual*, Queensland Health, May 1997
2	Ventilation for gaseous radioactive material	Where radioactive material is likely to emit a radioactive gas, the store must have separate and adequate mechanical ventilation to the outside air to reduce the concentration of gaseous radioactive material to at or near background concentrations within two minutes. The fan must operate for at least 2 minutes before a person opens or enters the store.	Australian Standard AS 2243.4 *Safety in laboratories Part 4: Ionizing radiations*, Section 7.1

Test	Compliance Test	Criteria for Passing the Test	Reference
Access control			
3	Store security	The store must be secured against unauthorised access.	NHMRC *Code of practice for the sae use of radiation gauges (1982)*, Section 7.1.3 NHMRC *Code of practice for the safe use of soil density and moisture gauges containing radioactive sources (1984)*, Section 6.1.2 NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 4.2.2 NHMRC *Code of practice for the safe use of sealed radioactive sources in borehole logging (1989)*, Section 6.1.2 AS 2243.4 *Safety in laboratories Part 4: Ionizing radiations*, Section 7.1

Test	Compliance Test	Criteria for Passing the Test	Reference
Labelling			
4	Store appropriately signed	The store must display a sign in a conspicuous location which contains the following information: • Radiation warning sign (trefoil) • The word “caution” or “warning” • Words to the general form of “store for radioactive substances” The symbol and lettering must be black on a yellow background.	NHMRC *Code of practice for the safe use of radiation gauges (1982)*, Section 7.1.3 NHMRC *Code of practice for the safe use of soil density and moisture gauges containing radioactive sources (1984)*, Section 6.1.2 NHMRC *Code of practice for the safe use of industrial radiography equipment (1989)*, Section 4.2.2 NHMRC *Code of practice for the safe use of sealed radioactive sources in borehole logging (1989)*, Section 6.1.2 Australian Standard AS 2243.4 *Safety in laboratories Part 4: Ionizing radiations*, Section 7.1

Table 20—Standard for Class 4 lasers used to carry out cosmetic or health related procedures on human beings

Test	Compliance Test	Criteria for Passing the Test	Reference
Protective housing			
1	Protective housing	Each laser must have a protective housing which, when in place, prevents human access to laser radiation in excess of Class 1, except when human access is necessary for the performance of the functions of the laser.	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.2.1
2	Service	Any parts of the housing or enclosure of a laser (including embedded lasers) that can be removed or displaced for service and which would allow access to laser radiation in excess of the accessible emission limit assigned and are not interlocked must be secured in such a way that removal or displacement of the parts requires the use of tools.	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.2.2

Test	Compliance Test	Criteria for Passing the Test	Reference
Access panels and safety interlocks			
3	Safety interlocks	A safety interlock must be provided for access panels of protective housings when both of the following conditions are met: (a) The access panel is intended to be removed or displaced during maintenance or operation; and (b) The removal of the panel gives human access to laser radiation levels in excess of the accessible emission limit to Class 3A; however, a safety interlock is not required if the interior if the interior accessible laser radiation is Class 3B, is in the range of 400 nanometres to 700 nanometres, and is less than five times the accessible emission limits of Class 2. Removal of the panel must not result in emission through the opening in excess of the accessible emission limit for Class 3A. The safety interlock must be of a design which prevents the removal of the panel until the accessible emission levels are below the accessible emission limits of Class 4 and, in any case, below the accessible emission limits for Class 3B, is in the range of 400 nanometres to 700 nanometres, and is less than five times the accessible emission limits of Class 2. Inadvertent resetting of the interlock must not in itself restore emission values above the accessible emission limits of the class assigned nor above the limits specified above.	Australian/New Zealand Standard 2211.1:1997 *"Part 1: Equipment classification, requirements and user's guide"* Section 4.3.1

Test	Compliance Test	Criteria for Passing the Test	Reference
4	Override mechanisms	If a deliberate override mechanism is provided, it must not be possible to leave the override in operation when the access panel is returned to its normal position. The interlock must be clearly associated with a label containing the following information: • "Caution—Laser radiation when open and interlocks defeated." • "Avoid eye or skin exposure to direct or scattered radiation." If the output of the laser is outside the wavelength range from 400 nanometres to 700 nanometres, the words "laser radiation" must read "invisible laser radiation". If the output is at wavelengths both inside and outside this wavelength range, the words "laser radiation" must read "visible and invisible laser radiation". If the output of the laser is in the wavelength range from 400 nanometres to 700 nanometres, the wording "laser radiation" must read "laser light". For light emitting diode (LED) radiation, the word "laser" on the label shall be replaced by "LED"	Australian/New Zealand Standard 2211.1:1997 *"Part 1: Equipment classification, requirements and user's guide"* Sections 4.3.2, 5.10, 5.11, 5.12

Test	Compliance Test	Criteria for Passing the Test	Reference
Remote interlock connector			
5	Remote interlock connector	The laser must have a remote interlock electrical connector. When the terminals of the connector are open-circuited, the accessible radiation must not exceed the accessible emission limit for Class 3A.	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.4
Key control			
6	Key control	The laser must incorporate a key-operated master control. The key must be removable and the laser radiation must not be accessible when the key is removed. The term "key" includes any of the control devices, such as magnetic cards and cipher combinations.	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.5

Test	Compliance Test	Criteria for Passing the Test	Reference
Laser radiation emission warning			
7	Warning devices	The laser must give an audible or visible warning when it is switched on or if capacitor banks of a pulsed laser are being charged or have not been positively discharged. The warning device must be failure to safety or redundant. Any visible warning devices must be clearly visible through protective eyewear specifically designed for the wavelength(s) of the emitted laser radiation. The visible warning device(s) must be located so that viewing does not require exposure to laser radiation in excess of the accessible emission limit for Class 2.	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.6.1
8	Warning device distances	Each operational control and laser aperture that can be separated by 2 metres or more from a radiation warning device must itself be provided with a radiation warning device. The warning device must be clearly visible or audible to the person in the vicinity of the operational control or laser aperture	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.6.2
9	Aperture indication	Where the laser emission may be distributed through more than one output aperture, then a visible warning device must be clearly visible or audible to the person in the vicinity of the operational control or laser aperture.	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.6.3

Test	Compliance Test	Criteria for Passing the Test	Reference
Beam stop or attenuator			
10	Beam stop or attenuator	Each laser must incorporate one or more permanently attached means of attenuation (beam stop or attenuator, other than a laser energy source switch, mains connector or key control). The beam stop or attenuator must be capable of preventing human access to laser radiation in excess of the accessible emission limits for Class 3A.	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.7
Controls			
11	Controls	Each radiation apparatus must have controls located so that adjustment and operation do not require exposure to laser radiation in excess of the accessible emission limits for Class 2.	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.8

Test	Compliance Test	Criteria for Passing the Test	Reference
Viewing optics			
12	Viewing optics	Any viewing optics, viewport or display screen incorporated in a laser must provide sufficient attenuation to prevent human access to laser radiation in excess of the accessible emission limits for Class 1, and for any shutter or variable attenuator incorporated in the viewing optics, viewports or display screen, a means must be provided to: (a) Prevent human access to laser radiation in excess of the accessible emission limits for Class 1 when the shutter is opened or the attenuation varied; and (b) Prevent opening of the shutter or variation of the attenuator when exposure to laser radiation in excess of the accessible emission limits for Class 1 is possible.	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.9
Scanning safeguard			
13	Scanning safeguards	Lasers intended to emit scanned radiation, and classified on this basis, must not, as a result of scan failure or of variation in either scan velocity or amplitude, permit human access to laser radiation in excess of the accessible emission limit for Class 4 lasers.	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Section 4.10

Test	Compliance Test	Criteria for Passing the Test	Reference
"Walk-in" access			
14	Access	If a protective housing is equipped with an access panel which provides "walk in" access then: (a) Means must be provided so that any person entering the housing can prevent unintentional activation of the laser hazard; and (b) An emission warning device must be situated so as to provide adequate warning to any person, who might be within the housing.	Australian/New Zealand Standard 2211.1:1997 *"Part 1: Equipment classification, requirements and user's guide"* Section 4.12

Test	Compliance Test	Criteria for Passing the Test	Reference
Labeling			
15	Labeling of apparatus	Permanently fixed, legible and clearly visible labels must be so positioned that they can be read without the necessity for human exposure to laser radiation. The label must contain the laser warning sign and the following words: • Laser radiation • Avoid eye or skin exposure to direct or scattered radiation • Class 4 laser product Additionally, a label must be affixed close to each aperture which bears the words: • Laser aperture; or • Avoid exposure—laser radiation is emitted from this aperture Text borders and symbols must be black on a yellow background. If the output of the laser is outside the wavelength range from 400 nanometres to 700 nanometres the words "laser radiation" must read "Invisible laser radiation". If the output is at wavelengths both inside and outside this wavelength range, the "laser radiation" must read "visible and invisible laser radiation". If the output of the laser is in the visible wavelength range from 400 nanometres to 700 nanometres, the working "laser radiation" must read "laser light". For light emitting diode (LED) radiation, the word "laser" on the label must be replaced by "LED".	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Sections 5.1, 5,7, 5.10, 5.11, 5.12

Test	Compliance Test	Criteria for Passing the Test	Reference
16	Explanatory label	Each radiation apparatus must be labelled with an explanatory label which contains: • The maximum output of the laser radiation • The pulse duration (if appropriate) • The emitted wavelength(s). The identity number and publication date of the Australian Standard, or equivalent, to which the product was classified must also be included on the explanatory label, or in close proximity, on the laser. This label must be permanently fixed, legible and clearly visible and must be positioned that it can be read without the necessity for human exposure to laser radiation.	Australian/New Zealand Standard 2211.1:1997 *"Part 1: Equipment classification, requirements and user's guide"* Sections 5.8, 5.10, 5.11, 5.12

Test	Compliance Test	Criteria for Passing the Test	Reference
17	Labels for access panels	Each connection, each panel of a protective housing and each access panel of a protective enclosure which when removed or displaced permits human access to laser radiation in excess of the accessible emission standards for Class 1 must have affixed a label bearing the words: • "Caution—laser radiation when open." • "Avoid eye or skin exposure to direct or scattered radiation." If the output is at wavelengths both inside and outside this wavelength range, the "laser radiation" must read "visible and invisible laser radiation". If the output of the laser is in the visible wavelength range from 400 nanometres to 700 nanometres, the wording "laser radiation" must read "laser light". For light emitting diode (LED) radiation, the word "laser" on the label must be replaced by "LED".	Australian/New Zealand Standard 2211.1:1997 "*Part 1: Equipment classification, requirements and user's guide*" Sections 5.9, 5.10, 5.11, 5.12

Table 21—Standard for premises at which Class 4 lasers are used to carry out cosmetic or health related procedures

Test	Compliance Test	Criteria for Passing the Test	Reference
1	Airborne contaminants	In cases where significant amounts of airborne debris are likely, airborne contaminates must be captured as near as practicable to the point of evolution and removed by localised exhaust ventilation. This must be designed to ensure that infective agents are not passed downstream in the air handling/exhaust system.	Australian Standard/New Zealand Standard 4173:1994 "*Guide to the safe use of lasers in health care*" Section 9.4
2	Fire extinguishing equipment	Fire extinguishing equipment must be available in the laser treatment area. Fire retardant surgical drapes must be available for procedures where there is a risk of accidental irradiation.	Australian/New Zealand Standard 4173:1994 "*Guide to the safe use of lasers in health care*" Section 9.13

Test	Compliance Test	Criteria for Passing the Test	Reference
3	Warning indicators	All entrances must be provided with a laser warning sign. All access doors to premises where Nd-YAG or Argon lasers are used must have a visible alarm which indicates that the laser is in use and a warning sign which must include the following information: • "Warning" • "Laser in operation" • "Do not enter when light above door is illuminated"	Australian/New Zealand Standard 4173:1994 "*Guide to the safe use of lasers in health care*" Table 9.15, 9.16, 9.17
4	Windows	For premises in which lasers other than carbon dioxide lasers are used, screens must be fitted inside the window to eliminate vision into the premises.	Australian/New Zealand Standard 4173:1994 "*Guide to the safe use of lasers in health care*" Table 9.15, 9.16, 9.17

ENDNOTES

1. Laid before the Legislative Assembly on . . .
2. The administering agency is the Department of Health.