Australian Government

Australian Radiation Protection and Nuclear Safety Agency

Invitation to Make Submissions

NATIONAL DIRECTORY FOR RADIATION PROTECTION
Amendment No. XX, 2014

Disposal of Radioactive Material

CONSULTATION DRAFT

13 June 2014

Closing date for submissions is **1 August 2014**.

Please send all submissions to:

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(**Electronic submissions are preferred**)

All submissions will be held in a register of submissions, and unless marked confidential, may be made public.

NATIONAL DIRECTORY FOR RADIATION PROTECTION

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Approved by Radiation Health Committee, ?? ?? 2014

3.2 Exemptions

Delete existing footnote 12

[12] All dealings with all radioactive material below the activity concentration or activity levels in Schedule 4 of the Directory are exempt from regulation without approach to the Authority. In relation to the transport of radioactive material, the activity concentration levels for exempt material, the activity limits for exempt consignments, and the modifying factor in clause 107(e) in the *Code of Practice for the Safe Transport of Radioactive Material* apply.

Insert new footnote 12

[12] All dealings with all radioactive material below the activity concentration or activity levels in Schedule 4 of the Directory, other than for the control of discharges which are dealt with in clause 4.2.2, are exempt from regulation without approach to the Authority. In relation to the transport of radioactive material, the activity concentration levels for exempt material, the activity limits for exempt consignments, and the modifying factor in clause 107(e) in the *Code of Practice for the Safe Transport of Radioactive Material* apply.

Delete existing clause 3.2.7

3.2.7 A radioactive source listed in Schedule 5 must be exempted from the notification, registration or licensing requirements specified, subject to disposal of radioactive waste meeting the requirements of Section 4.2.2 (in preparation) and Schedule 14 (in preparation).

Insert new clause 3.2.7

3.2.7 A radioactive source listed in Schedule 5 must be exempted from the notification, registration or licensing requirements specified, subject to disposal of that source meeting the requirements of Section 4.2.2.

4.2 Requirements for authorising practices

Delete existing clause

Requirements applied to authorisations for practices by the Authority must include the set of requirements specified in Schedule 7 for the relevant categories.

Insert new clause 4.2.1

4.2.1 Requirements applied to authorisations for practices by the Authority must include the set of requirements specified in Schedule 7 for the relevant categories.

The following subsection is added to Section 4.2 in order to provide for disposal of radioactive material by the user.

Insert new clause 4.2.2

4.2.2 No authorisation is required to dispose of radioactive material if the disposal is in accordance with Schedule 14.

Schedule 5 – Exempt radiation generating apparatus, electron tubes and radioactive sources

Delete existing footnote 20

[20] It should be noted that the provisions requiring authorisation prior to disposal of radioactive materials still apply, unless the disposal is in accordance with Schedule 14 (in preparation).

Insert new footnote 20

[20] It should be noted that the provisions requiring authorisation prior to disposal of radioactive materials still apply, unless the disposal is in accordance with Schedule 14.

Schedule 7 – Requirements for Licensing Specific Practices

Delete reference statement

(Refer section 4.2)

Insert reference statement

(Refer section 4.2.1)

Schedule 14 – Requirements for the disposal of radioactive material by the user

(Refer section 4.2.2)

A new Schedule 14 is inserted as follows:

For the purpose of Section 4.2.2, the radioactive material must meet the following criteria:

S14.1 Disposal of Radioactive Material via Landfill

Radioactive material for final placement into landfill must:

1. only be in solid form;
2. be contained within packaging designed so that:
   (a) the smallest overall external dimension of each package is not less than 10 cm;
   (b) the package can be easily handled;
   (c) there are at least two complete layers of packaging between the radioactive material and the exterior of the package, one layer of which is waterproof;
   (d) the outer layer of each package:
      (i) as far as practicable, prevents the collection and retention of water; and
      (ii) can be easily decontaminated;
   (e) as far as practicable, the packaging will retain its contents during transport to the landfill site;
   (f) no individual package contains more than the relevant Landfill Package Activity Value in Column 2 of Table S14.1 of this Schedule;
   (g) the dose-rate at the surface of any individual package does not exceed 5 μSv/h;
   (h) the maximum non-fixed external contamination on any individual package does not exceed:
      (i) 4 Bq/cm^2 for beta and gamma emitters; or
      (ii) 0.4 Bq/cm^2 for alpha-emitters having a half-life greater than 10 days;
3. be limited to no more than 10 packages containing radioactive material from the person initiating the disposal in any 7 day period at the one landfill site;
4. not be placed in the recycling waste stream; and
5. be recorded in a register that is kept by the person initiating the disposal.

S14.2 Disposal of Radioactive Material via Sewer

Radioactive material disposed into the sewerage system must:

1. consist only of aqueous materials,
2. only be released so that:
   - (i) the annual activity of a radioactive material from the site to a sewer does not exceed the value in column 3 of Table S14.1 of this Schedule; and
   - (ii) the concentration at the input to a waste water treatment plant, calculated as the activity in (i) divided by the average annual dry weather flow through the waste water treatment plant to which the sewer connects, does not exceed that in column 4 of Table S14.1 of this Schedule; and
3. be recorded in a register that is kept by the person initiating the disposal.

S14.3 Disposal of Radioactive Material to the Atmosphere

Radioactive material released into the atmosphere must be:

1. limited so that the annual activity released at the point of discharge does not exceed the Air Discharge Values in Column 5 of Table S14.1 of this Schedule; and
2. recorded in a register that is kept by the person initiating the disposal.

Table S14.1 Landfill Package Activity, Sewerage Discharge and Air Discharge Values for Periodic Disposal of Very Low-Level Radioactive Material

Column 1	**Column 2 Landfill Discharge Values**	**Column 3 Sewerage Discharge Values**	**Column 4 Sewerage Discharge Values**	**Column 5 Air Discharge Values**
Radionuclide	**Landfill Package Activity Values(1) (Bq)**	**Annual activity to sewer from a site(1),(2) (Bq)**	**Resultant concentration(1) at input to a waste water treatment plant (Bq/m^3)**	**Annual activity released to atmosphere from the point of discharge(1) (Bq)**
^{3}H	10^{10}	2.0×10^{11}	9.1×10^{6}	1.0×10^{12}
^{14}C	10^{8}	1.8×10^{8}	1.0×10^{3}	1.0×10^{11}
^{18}F	10^{7}	2.3×10^{9}	1.0×10^{5}	2.5×10^{13}
^{22}Na	10^{7}	1.0×10^{6}	1.1×10^{0}	1.0×10^{7}
^{24}Na	10^{6}	1.0×10^{8}	1.1×10^{3}	1.0×10^{10}
^{32}P	10^{6}	1.0×10^{7}	7.1×10^{0}	1.0×10^{9}
^{33}P	10^{9}	3.0×10^{8}	6.3×10^{1}	3.0×10^{10}
^{35}S(inorganic)	10^{9}	3.3×10^{8}	1.1×10^{4}	1.0×10^{9}
^{36}Cl	10^{7}	7.1×10^{6}	3.3×10^{2}	1.0×10^{8}
^{45}Ca	10^{8}	3.0×10^{9}	1.1×10^{5}	1.0×10^{9}
^{51}Cr	10^{8}	1.0×10^{9}	1.1×10^{3}	1.0×10^{10}
^{59}Fe	10^{7}	1.0×10^{7}	1.1×10^{1}	1.0×10^{9}
^{57}Co	10^{7}	6.3×10^{8}	1.6×10^{2}	1.0×10^{10}
^{60}Co	10^{6}	5.6×10^{6}	7.9×10^{0}	8.3×10^{9}
^{63}Ni	10^{9}	6.3×10^{10}	6.6×10^{3}	8.3×10^{12}
^{65}Zn	10^{7}	7.0×10^{6}	3.2×10^{2}	3.0×10^{10}
^{67}Ga	10^{7}	1.0×10^{9}	1.1×10^{3}	1.0×10^{11}

Column 1	Column 2 Landfill Discharge Values	Column 3 Sewerage Discharge Values	Column 4 Sewerage Discharge Values	Column 5 Air Discharge Values
Radionuclide	**Landfill Package Activity Values(1) (Bq)**	**Annual activity to sewer from a site(1),(2) (Bq)**	**Resultant concentration(1) at input to a waste water treatment plant (Bq/m^3)**	**Annual activity released to atmosphere from the point of discharge(1) (Bq)**
^{85}Kr	10^5	–	–	7.7×10^{15}
^{89}Sr	10^7	2.0×10^9	1.7×10^3	1.0×10^9
^{90}Sr	10^5	1.0×10^7	4.6×10^2	3.0×10^{10}
^{90}Y	10^6	4.2×10^{10}	1.1×10^5	1.0×10^{11}
^{99}Mo	10^7	1.0×10^9	1.1×10^3	1.0×10^{10}
^{99}Tc	10^8	2.0×10^6	8.9×10^1	1.0×10^8
^{99m}Tc	10^8	7.0×10^8	1.1×10^4	1.0×10^{12}
^{111}In	10^7	1.0×10^9	1.1×10^3	1.0×10^{10}
^{123}I	10^8	8.3×10^9	1.1×10^4	1.0×10^{11}
^{125}I	10^7	1.0×10^9	1.1×10^3	1.0×10^9
^{129}I	10^6	1.8×10^7	8.3×10^2	1.3×10^9
^{131}I	10^7	1.0×10^8	1.1×10^2	1.0×10^9
^{137}Cs	10^5	1.7×10^7	5.1×10^1	1.4×10^{10}
^{147}Pm	10^8	1.0×10^{11}	1.1×10^5	1.0×10^{11}
^{153}Sm	10^7	3.2×10^{10}	1.5×10^6	6.3×10^{12}
^{201}Tl	10^7	1.0×10^9	1.1×10^3	1.0×10^{11}
^{223}Ra	10^6	1.3×10^8	5.7×10^3	5.9×10^8
^{241}Am	10^5	1.3×10^8	5.8×10^3	1.0×10^8
Radionuclides not listed in this Table	10 times the exemption limit for that radionuclide			

Notes

(1) When there is a mixture of radionuclides in the material to be disposed of to landfill, to a sewer or to air:

$$\sum_i \frac{C_i}{X_i} \leq 1$$

Where C_i is the activity or activity concentration of each isotope *i* to be disposed of, and

X_i is the activity or activity concentration discharge value, as appropriate, as given in Table S14.1 for each isotope *i*.

(2) A ‘site’ may be, for example, a university or a hospital from which there could be several individual points of disposal to the one sewer. The activities in this column are the total activity discharged from that site to the one sewer.

A new Annex 4 is inserted as follows:

Annex 4 – Disposal of radioactive material by the user

Introduction

Radioactive material is used extensively in medical, research and industrial applications. While the use of radioactive material has significant medical, research and industrial benefits, there is often a need to dispose of waste material generated during the particular process. As ionising radiation can be detrimental to human health and the broader environment, it is important to dispose of unwanted radioactive material with minimum effect on the health and safety of people and the environment.

Previously, requirements on the disposal of unwanted radioactive material by the user was contained in the NHMRC in its Radiation Health Series publication number 13, the *Code of Practice for the Disposal of Radioactive Wastes by the User* (1985) (RHS13) (NHMRC 1985). RHS13 provided a means of determining activities of radioactive material that could be approved for disposal to sewer or to landfill. Disposal of higher activities of radioactive material required additional consultation with and approval of the regulatory authority. The activity values calculated using RHS13 were based on 'reasonable' assumptions but not on any specific exposure scenarios.

Review of disposal requirements

Following a review of RHS13, the Radiation Health Committee (RHC) concluded that an agreed set of activities and activity concentrations for each commonly used isotope be prepared to promote a uniform approach to disposal of radioactive material in Australia. The RHC specified that the revised requirements should include disposal to landfill, sewer and atmosphere.

Further, RHC agreed that the values be such that no approval of the relevant regulatory authority would be required if the person were to dispose of the material with an activity or activity concentration below the value specified for the particular isotope. Where, however, this were not the case, regulatory approval would be required.

The revised approach

The NDRP entry and Schedule to replace RHS13 was developed to:

- be as simple as possible but as complex as necessary,
- have regard to current national and international guidance on disposal and discharge of radioactive material including the requirements for disposal and discharges of radioactive material in the IAEA Basic Safety Standards (IAEA 2012),
- have regard to currently available methodologies and international experience in dealing with disposal and discharge of radioactive material by users in hospitals, universities, etc.,
- take account of likely exposure of people and of the environment,
- be based on conservative but realistic, documented scenarios and modelling considered applicable to Australian conditions,

- consider the direction of the *Fundamentals for Protection Against Ionising Radiation* and *Code of Practice for Planned Exposure Situations* (ARPANSA 2014), and
- consider current practice in all Australian jurisdictions.

In applying these criteria, values expressed as an annual activity to account for exposure of people and an activity concentration for exposure of the environment were considered to be the simplest parameters.

Thus, NDRP entry 4.2.1 and the corresponding set of values in Schedule 14 represent activities and concentrations below which *no* approval for disposal and discharge would be required. This addresses an omission from RHS13, where approval was required for all disposal and discharge of radioactive material to sewer and to landfill. RHS13 did not address disposal to atmosphere (NHMRC 1985).

Thus, any person would be able to dispose of radioactive material below the activity specified in Schedule 14 to landfill. Further, any person could discharge radioactive material to a waterway or to the atmosphere below the specified activities and concentrations.

The specifications of the activities and concentrations were based on model sites such as universities or hospitals from which the discharges were made and from which there could be several individual points of disposal to the one sewer. The specified activities were therefore the total activity discharged from each site or facility to the one sewer.

The values of activity and concentration in Schedule 14 are *not* limits and it is not intended to suggest that higher values would be unacceptable. The values are merely estimates above which approval for disposal is required. Disposal or discharge above these values can be acceptable but would require approval. The values in Table S14.1 are therefore screening values below which *no* approval is required.

The derivation of values for Schedule 14

The dose criterion for disposal by the user

Although each isotope has an exemption activity and exemption activity concentration as set by the International Atomic Energy Agency (IAEA), and adopted into this Directory, the IAEA makes clear that these exemption levels are not intended to apply to the control of discharges (IAEA 2012).

It was therefore considered necessary to derive values for disposal to landfill, sewerage and the atmosphere that could be justified in accordance with international doctrine.

As discussed in Annex 2, exemption levels were derived based on scenarios where the maximum effective dose to an exposed individual would not be greater than 10 µSv a year under plausible normal circumstances.

Given the restricted opportunity for the likely exposure of people to radiation from the disposal of radioactive material by the means specified in Schedule 14, the threshold value for exposure of any person above which approval would be required was set at 100 µSv a year. Disposal of radioactive material with activity (and activity concentration where relevant) below the values in Schedule 14 would result in the exposure of a person of less than 100 µSv a year and would not harm the environment. Disposal of radioactive material below these values does not require approval.

It should be noted that where regulatory approval is required, i.e. when the values in Schedule 14 are exceeded, the radiation regulator is likely to have some restrictions on exposure, such as 300 μSv a year from any one source of radiation exposure or a limit of 1 000 μSv a year to any person from all sources of radiation exposure. The person initiating the disposal might then need to carry out an assessment to show that these exposures will not be exceeded and that there will be no harm to the environment.

The models used to estimate exposure of people and the environment

Many of the models available for estimating exposures of people and the environment from disposal and discharges use an approach in line with that presented in IAEA Safety Report Series No. 19 (IAEA 2001). This approach uses simple transfer parameters that take account of several environmental processes, and implicitly assumes a state of equilibrium between the concentration in water or air and other environmental materials.

Once the concentration of discharged radionuclides in environmental materials is estimated, the routes by which ‘receptors’, such as representative members of the public, might come into contact with the discharged material are identified and a critical group determined.

This approach was considered appropriate for facilities where the application of annual averages is suitable.

In the models selected to generate the values for Schedule 14, two main categories of exposure were considered:

- External exposure from radionuclides present in the air or in material incorporated in, for example, soils or sediment, and
- Internal exposure from the inhalation or ingestion of radionuclides present in air or incorporated in water or foods respectively.

The relative importance of different exposure pathways were dependent on the:

- magnitude of the discharge,
- route of discharge,
- physical and chemical characteristics of the radionuclides discharged, and
- characteristics of the radioactive decay.

Values obtained using this methodology tend to be highly conservative and therefore are suitable for use for screening.

It was considered that regulators would benefit from adopting such generic models for assessing radiation dose to exposed persons.

Disposal to landfill

Scenarios adopted in the Commission of the European Communities were used to obtain the activities for disposal to landfill (EC 1993). Disposal to landfill is one of the scenarios considered in this European document and is not the most restrictive scenario for all radioisotopes. The landfill scenarios include exposure of the public from accidental tampering with the radioactive source and from inhalation, ingestion and skin exposure pathways. The landfill site is assumed to be a generic small site with a capacity of domestic waste of 1.5×10^4 tonnes over an area of 1×10^{-2} km^2.

The use of the values from that document therefore provides some conservatism in the estimation of radiation exposures.

Based on the rationale described in the dose criterion above, the landfill package activity values were calculated as ten times the exemption activity level listed in Schedule 4 of this Directory.

Disposal to sewer

The derived levels of radioactive waste for disposal to the sewer by the user were based on calculation of the annual activity of radioactive material that could result in a dose of 100 µSv in a year to the most exposed individual and a concentration that would result in an exposure rate of less than 10 µGy h^{-1} to the most exposed organism.

Exposure of people

Three methodologies were considered to determine exposure to people. Two methodologies were from the UK – that for calculation of Generalised Derived Constraints (GDCs) (NRPB 2000, NRPB 2010) and that for the 'Initial radiological assessment methodology' (Environment Agency 2006), which is based on dose per unit release (DPUR) data. The third methodology is that used by the IAEA to calculate clearance values in its Tecdoc-1000 (IAEA 1998). It was noted that these models and data were developed for application in temperate European and North American conditions but were deemed applicable for the Australian situation, particularly in the urban areas where such disposal is likely to occur.

Estimates of the annual activities of radioactive materials that would not result in an annual dose above 100 µSv were derived using each methodology. Table S14.1 contains the minimum of the available values.

All three approaches base their modelling on principles similar to those described in IAEA Safety Series 19 (IAEA 2001) but make different assumptions. The three data sources combined included all the isotopes in the NDRP Schedule. None of the three approaches considered exposure of the environment.

The methodologies considered three main exposure groups and relevant age groups (infants, adults, etc.) within each group and base their recommendations on the most restrictive scenario.

The three exposure groups considered were:

1. Sewage plant workers who were considered to spend a working year at the waste water treatment plant and who were exposed to radionuclides in sludge and effluent. Exposure from external radiation, inhalation and ingestion were considered.

2. Members of the public who were exposed to radionuclides in river water that has received treated effluent. Exposures occurred due to:
   - external exposure from sediments,
   - drinking water and eating fish from the river, and
   - producing and consuming green vegetables and potatoes on land irrigated by the river water.

3. Members of the public assumed to live adjacent to farmland treated repeatedly with sewage sludge and to consume animal products produced from the treated land – foods consumed were assumed to have been produced on treated farmland, intakes were assumed to be at critical group levels.

(The IAEA methodology did not consider the transfer of radionuclides to the terrestrial food chains due to irrigation or treatment with sewage sludge.)

Each methodology made conservative, but slightly different assumptions.

Both UK methodologies assumed that the dry weather flow through the waste water treatment plant was ~60 m^3 day^{-1}, serving a population of 400 people. The IAEA assumed a plant that was 40 times larger.

The GDC calculation assumed that workers were exposed to sludge for 1000 hours a year; the DPUR calculation assumed exposure for 500 hours a year and the IAEA methodology assumed exposure for 2000 hours a year.

The GDC and IAEA calculations assumed that all the radionuclide remained in effluent and that all the radionuclide remained in sludge. The DPUR calculations partitioned the radionuclide between effluent and sludge.

The DPUR calculations were modified to allow exposure of workers to sludge for 1000 hours a year and to remove the partitioning between effluent and sludge, thus making the assumptions closer to those used for the GDC calculations.

The GDCs are the discharge rates to a sewer given in Bq y^{-1} and are based on a dose criterion of 300 µSv y^{-1}. The IAEA also specified clearance values (IAEA 1998) although these were based on 10 µSv y^{-1} exposure scenarios. The DPUR methodology resulted in values for the dose, in µSv y^{-1}, resulting from a discharge of 1 Bq y^{-1} for various exposure pathways and age groups.

Therefore in order to determine values for this Directory, GDC values were divided by three to equate to 100 µSv y^{-1}. Conversely, the IAEA clearance values were multiplied by a factor of 10. The (worst case, modified) DPUR values were scaled to yield the activity that corresponded to a dose of 100 µSv y^{-1}.

The most restrictive annual activity is listed in Table S14.1.

Although the three data sources gave different values, the agreement was reasonable for common radionuclides and the use of values from documented sources was considered to be the best approach. A person wishing to discharge radioactive material can use this information as a basis for calculations of potential exposures from higher activities of radioactive material.

Protection of the environment

A screening dose rate value of 10 µGy h^{-1} to biota was used as the no-effect level, below which environmental risks would be negligible.

Corresponding concentrations in freshwater and the marine environment were then calculated using the Erica assessment tool.

The Erica assessment tool (Brown et al 2008) (free download available) provides values of Environmental Media Concentration Limits (EMCLs) for water and sediment in freshwater and marine environments in its parameters database – risk characterisation. These EMCLs represent the lowest concentration derived from water or sediment for freshwater or marine environments below which all biota would receive an exposure of less than 10 µGy h^{-1}. The concentration in water (freshwater or marine) corresponding to the EMCL in sediment was obtained by dividing the sediment concentration by the distribution coefficient (Kd).

The minimum concentration obtained by these calculations for each isotope in the Erica database was used in the derivation of values for Table S14.1.

The exit point from a waste water (sewage) treatment plant was chosen as the calculation point for the concentrations derived from the Erica assessment tool. The activity concentration at the exit point was taken as equal to that at the input to the plant.

Concentrations at the input to the waste water treatment plant corresponding to the annual activity obtained for the three methodologies for protection of people, discussed above, were calculated. The concentration at the input to a waste water treatment plant listed in Table S14.1 is the minimum of the available concentrations (for protection of people and of the environment) for each isotope.

The environment considerations are very conservative and the most limiting organism may not even be present in many disposal situations. However, as the Schedule is intended for screening purposes, the use of the most conservative value for each radionuclide was necessary hence the requirement in Schedule 14 for both the activity and the activity concentration to be met for disposal to sewer.

Not all the isotopes in Table S14.1 are contained in the Erica assessment tool and concentration values will be reviewed as more Erica data become available.

Disposal to atmosphere

The same three methodologies discussed above were used to generate annual activities that could be dispersed to atmosphere with no approval. The calculations included those of doses arising from inhalation, external exposure and ingestion. Several assumptions were made regarding:

- discharge point height above ground,
- wind patterns,
- distance to closest human habitation,
- distance to farmland,
- consumption of food (crops and animal products) from this farmland, and
- build-up of radionuclides in the environment.

Again, radiation doses were calculated for methodologies available for each radionuclide cases and the most restrictive level was used as the value in Table S14.1.

Applicability of the values in Schedule 14 to short-term releases

Radioactive material discharged to the aquatic environment generally occurs over a short period each day and discharges are unlikely to be continuous.

The three methodologies used to generate annual activities in Table S14.1 assumed that the activity is discharged continuously and uniformly throughout the year. Given the other uncertainties in the assessment process, the results based on continuous release were considered appropriate for these normal operational daily variations in discharges.

References

Australian Radiation Protection and Nuclear Safety Agency 2014, *Fundamentals for the the Protection Against Ionising Radiation*, Radiation Protection Series No. 1 (RPS 1), ARPANSA (2014).

Brown, J.E., Alfonso, B., Avila, R., Beresford, N.A., Copplestone, D., Pröhl, G., Ulanovsky, A. (2008). *The ERICA Tool.* Journal of Environmental Radioactivity 99, 1371–1383.

Commission of the European Communities, The (EC) (1993) – 65 *Principles and Methods for Establishing Concentrations and Quantities (Exemption values) below which Reporting is not Required in the European Directive* (1993)

Environment Agency 2006, *Initial radiological assessment methodology – part 2 methods and input* data Science Report SC030162/SR2, United Kingdom.

International Atomic Energy Agency 1998, IAEA Tecdoc 1000 *Clearance of materials resulting from the use of radionuclides in medicine, industry and research* (Data from Tables III and IV), IAEA, Vienna.

International Atomic Energy Agency 2001, *Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment*, Safety Reports Series 19, IAEA, Vienna.

International Atomic Energy Agency 2010, IAEA-Tecdoc 1638 *Setting Authorized Limits For Radioactive Discharges: Practical Issues To Consider Report For Discussion*, Vienna.

International Atomic Energy Agency 2012, *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*, Interim Edition General Safety Requirements Part 3 No. GSR Part 3 (Interim), IAEA, Vienna.

National Health and Medical Research Council 1985, *Code of practice for the disposal of radioactive wastes by the user* (1985), RHS 13, Canberra.

National Radiological Protection Board 2000, Documents of the NRPB Vol 11 No 2. *Generalised Derived Constraints for Radioisotopes of Strontium, Ruthenium, Iodine, Caesium, Plutonium, Americium and Curium*, NRPB.

National Radiological Protection Board 2010, HPA-CRCE-004, *Generalised Derived Constraints for Radioisotopes of Hydrogen, Carbon, Phosphorus, Sulphur, Chromium, Manganese, Cobalt, Zinc, Selenium, Technetium, Antimony, Thorium and Neptunium*, HPA.

Other documents consulted

- *Recommendations for the Discharge of Patients Undergoing Treatment with Radioactive Substances* (2002), Radiation Protection Series No. 4 (RPS 4), ARPANSA.
- *Code of Practice for the Safe Transport of Radioactive Material* (2008 Edition), Radiation Protection Series No. 2 (RPS 2), ARPANSA.
- *Safety Guide for Classification of Radioactive Waste* (2010), Radiation Protection Series No. 20 (RPS 20), ARPANSA.
- ARPANSA Regulatory Guide: *Plans & Arrangements for Managing Safety* v4 2013