Australian Government

Radiation Health and Safety Advisory Council

SCOPING REVIEW OF ISSUES RELATED TO THE MANAGEMENT OF INTERMEDIATE LEVEL RADIOACTIVE WASTE IN AUSTRALIA

April 2010

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RADIATION HEALTH AND SAFETY ADVISORY COUNCIL

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1. INTRODUCTION

Council agreed on 27 February 2009 to undertake a scoping review of the types of intermediate level waste currently within Australia, and provide a report to the CEO of ARPANSA. The report should include discussion on the types of regulatory guidance required for the safe management and disposal of this waste. It was agreed the review will be conducted as part of Council's consideration of emerging issues and issues of major concern to the community in radiation protection.

While Australia does not have any high level waste, the CEO has identified the need to examine the extent of the inventory of intermediate level waste and consideration of further regulatory guidance necessary for the management of this waste.

The previous Council carried out considerable work on intermediate level waste during the last triennium, leading to advice and preliminary recommendations to the CEO on 24 September 2008. The CEO discussed Council's report at the 27 February 2009 meeting, resulting in a request that Council undertake this scoping review. The CEO emphasised that the review was to focus on investigating Australia's intermediate level radioactive waste (ILW), an important part of which would be examination of the activities and activity concentrations of radionuclides classified as ILW, and the mass, volume, physical and chemical forms of the different types of ILW.

2. TERMS OF REFERENCE

To provide a report to the CEO of ARPANSA reviewing the types of intermediate level waste in Australia and the types of regulatory guidance that are required to be developed.

The report should consider and discuss:

- Identification of types and volumes of intermediate level waste generated in Australia;
- International guidance and recent developments in the management and disposal of intermediate level waste;

- The current status of government policy on management and disposal of Australia's radioactive waste by the States, Territories and the Commonwealth; and
- The type of regulatory or other guidance required to be developed.

In preparing this report, Council identified a number of important additional areas for consideration, and has therefore proposed that the CEO take into account these matters in addition to Council's recommendations on the Terms of Reference.

3. BACKGROUND

In responding to the CEO's request of February 2009, Council noted that the majority of radioactive waste is in long-term storage, as there is no existing disposal pathway in Australia. With the exception of the Mt Walton facility in WA, which deals only with waste originating in WA, and instances where waste is disposed of at the site where it originated (e.g. Parks Australia North, Maralinga, Little Forest Burial Ground, and various mine sites), there are no disposal facilities in Australia. Hence, apart from those radioactive sources that can be returned to the original supplier and short-lived waste from medical applications, radioactive waste must be kept in long-term storage. Currently this occurs at many sites throughout Australia. Dealing with radioactive waste has now become a priority. For example, the return to Australia of radioactive waste arising from the reprocessing of spent fuel from the operations of ANSTO's MOATA and HIFAR reactors is due to commence from 2015. A significant timeframe is usually required to develop and licence a radioactive waste management facility.

Australia has a 30 year history of trying to establish a national disposal pathway for radioactive waste. An attempt to establish a National Radioactive Waste Repository commenced following recommendations of the National Health & Medical Research Council (NHMRC) in October 1975. After many years of exhaustive processes to identify a suitable site, the project to establish a national repository was terminated in 2004.

Australia has obligations under the Joint Convention for the Safe Management of Spent Fuel and the Safe Management of Radioactive Waste. The Joint Convention is a legally binding international treaty on safety in these areas. It represents a commitment by participating Countries to achieve and maintain a consistently high level of safety in the management of spent fuel and of radioactive waste as part of the global safety regime for ensuring the proper protection of people and the environment.

The long term storage of radioactive waste at many sites throughout Australia, without a clearly defined disposal pathway, leaves the potential for significant health, safety and environmental issues to arise. These include occupational health risks in the management of radioactive waste, public health risks and security issues. For example, security of sources is a significant consideration when waste is stored at many sites, as it may lead to a high risk of orphan (lost, stolen or abandoned) sources and the potential for serious accidents, safety and security risks. Overseas countries have reported accidents resulting from the loss of control over radioactive sources where corporate memory has been lost. For example, the radiological accident in Goiania in Brazil in 1988, where several people died, many were injured and a wide area was contaminated when scavengers found and cut open an unused, unsecured radiotherapy source of Cs-137[1].

The previous Council has provided reports to the CEO on radioactive waste issues (RHSAC 2002, RHSAC 2004, RHSAC 2008). The most recent report was provided by the Council in September 2008, wherein Council acknowledged that its response was limited due to its term of appointment ending at that time. This report concentrated on the management and disposal of long-lived intermediate level radioactive waste (LLILW). The report made the following preliminary recommendations:

"While Council has not had time to conduct an in-depth evaluation at this stage, it acknowledges that Australia has a long-term need for the management and disposal of LLILW and makes the following preliminary recommendations:

1. The feasibility of intermediate depth disposal for the different types of LLILW in Australia should be further investigated. For example, borehole disposal may be suitable for radium legacy wastes and a range of disused sealed sources, and should be examined in more detail.

2. Opportunities for international collaborations should be investigated by both ARPANSA and waste facility operators to enhance Australia's expertise in radioactive waste management, safety assessment, development of waste acceptance criteria and regulation of radioactive waste management facilities.

3. ARPANSA should develop regulatory guidance on the management and disposal of LLILW, including guidance for applicants proposing to establish a waste management facility. Guidance should also be developed on how applications for such facilities will be assessed."

The CEO invited the Department of Resources, Energy and Tourism (RET) to comment on Council's report, and their response included the following comment on the general point of deciding between storage and disposal of radioactive waste:

"RET sees this decision as one to be taken by proponents rather than regulatory agencies. The previous government, for example, had considered that in view of the relatively small volume of Commonwealth intermediate level waste holdings, indefinite storage was the preferred management approach that it would implement."

RET also made the following comments on Council's preliminary recommendations:

1. This is a matter which will be considered by RET in the light of the Government decisions on its radioactive waste management policy. RET notes that borehole disposal offers the prospect of cost-

[1] IAEA (1988), The Radiological Accident in Goiania, September 1988, Vienna (ISBN 92-0-129088-8)

effective disposal of some intermediate level wastes should the Government decide to pursue a disposal route for management of this material.

2. RET agrees that whatever option for management of Australia's radioactive waste is adopted by the Government it should be expedited with the benefit of relevant international experience. RET notes that such experience is potentially available through contractors with overseas affiliates that are actively involved in the siting, construction and operation of radioactive waste management facilities. From the regulatory perspective, ARPANSA is actively involved in a number of forums convened by the International Atomic Energy Agency.

3. RET agrees with this recommendation, noting that ARPANSA has already issued some guidance of this nature (*Regulatory Guidance for Radioactive Waste Management Facilities: Near Surface Disposal Facilities*; and *Storage Facilities*, December 2006).

4. HISTORY OF ATTEMPTS TO ESTABLISH A NATIONAL RADIOACTIVE WASTE REPOSITORY

Council is aware of the considerable work over many years attempting to establish a National Radioactive Waste Repository for low level radioactive waste and a store for intermediate level waste. The search for a suitable site for a repository included a three phase site selection process, which had ultimately identified a site near Woomera in the Billa Kalina region of South Australia. An application had been submitted to ARPANSA for a licence, and this application had been peer-reviewed by an IAEA International Review Team [May 2004][2].

In July 2004 the then Prime Minister announced that the Government would not proceed with the establishment of the national repository, thus leaving the responsibility for radioactive waste for each jurisdiction to manage independently. At the same time the Prime Minister sought a commitment from all States and Territories that they adopt world's best practice in management of radioactive waste, including undertaking an immediate and comprehensive inventory; establishing safe and secure storage facilities; and establishing appropriate disposal arrangements. ARPANSA was asked to work cooperatively with relevant State and Territory regulators to establish nationally consistent operating principles and guidelines.

The most recent information on radioactive waste management activities being undertaken in Australia is reported in the National Report to the 3rd Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, held in Vienna in May 2009. The information in the report was compiled in late 2008. All jurisdictions were contacted to determine if any activities not contained in the

[2] IAEA/NSR/2004 Nuclear Safety Review For the Year 2004

National Report were being undertaken. No new activities were identified. This information is summarised in Attachment 1. For both ACT and SA, there was no information on current arrangements in the Joint Convention National Report. The information for current arrangements in SA and ACT was provided by the jurisdictions for the development of Council's report. In relation to inventories of radioactive waste, South Australia conducted a full audit of radioactive material, including radioactive waste in 2003 and Tasmania is currently planning to undertake an audit. While some other jurisdictions have information on radioactive waste inventories, Council considers it would be valuable for all jurisdictions to undertake a current audit of radioactive material awaiting disposal, including that under government control and elsewhere.

In regard to the radioactive waste owned by the Commonwealth, work in this area since 2004 has involved considering options for managing the Commonwealth's radioactive waste. Three sites in the Northern Territory were considered by the previous Government, and a fourth site in NT was volunteered by the traditional Aboriginal owners of Muckaty Station.

In going to the 2007 election, the policy of the present Government was:

- Not to proceed with sites identified in the NT by the previous government unless contracts were in place;
- Repeal the Commonwealth Radioactive Waste Management Act 2005;
- Establish a new process for identification of sites that allows access to appeal mechanisms;
- Identify a site in accordance with that new process;
- Ensure full community consultation in decision making; and
- Commit to international best practice.

On 24 February 2010, the Government introduced the National Radioactive Waste Management Bill 2010 to the Australian Parliament. The Bill repeals the previous Government's Commonwealth Radioactive Waste Management Act 2005, and provides a process to establish a purpose-built national facility for managing radioactive waste. The Bill was referred to a Senate Committee which has invited public submissions and is due to report by 30 April 2010.

5. CLASSIFICATION OF RADIOACTIVE WASTE

A general definition of radioactive waste has been included in the draft Recommendations for the Classification of Radioactive Waste, currently being prepared by the Radiation Health Committee (RHC). The definition proposed by RHC is as follows:

Radioactive waste means radioactive material for which no further use is foreseen, and which is under regulatory control by the relevant regulatory authority.

Council noted that this definition is a simplified form of the definition used in the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Section 2.0 of The IAEA Safety Guide on Classification of Radioactive Waste (GSG-1) defines intermediate level waste as follows:-

2.28 ….waste that contains long lived radionuclides in quantities that need a greater degree of containment and isolation from the biosphere than is provided by near surface disposal. Disposal in a facility at a depth of between a few tens and a few hundreds of metres is indicated for ILW. Disposal at such depths has the potential to provide a long period of isolation from the accessible environment if both the natural barriers and the engineered barriers of the disposal system are selected properly. In particular, there is generally no detrimental effect of erosion at such depths in the short to medium term. Another important advantage of disposal at intermediate depths is that, in comparison to near surface disposal facilities suitable for LLW, the likelihood of inadvertent human intrusion is greatly reduced. Consequently, long term safety for disposal facilities at such intermediate depths will not depend on the application of institutional controls.

2.29 …….the boundary between the LLW class and the ILW class cannot be specified in a general manner with respect to activity concentration levels, because allowable levels will depend on the actual waste disposal facility and its associated safety case and supporting safety assessment. For the purposes of communication pending the establishment of disposal facilities for ILW, the regulatory body may determine that certain waste constitutes LLW or ILW on the basis of generic safety cases.

The Radiation Health Committee (RHC) has adopted effectively the same classification of ILW in their draft Recommendations.

In Australia waste falling within this definition, and therefore classified as ILW, typically includes higher activity disused sources, some radiation gauges, radiotherapy sources, radium legacy waste, waste from mineral sands processing many years ago, and operational wastes from ANSTO's activities, including from radiopharmaceutical production. It also includes waste arising from the reprocessing of spent fuel from HIFAR, and will in future include waste from the OPAL reactor.

Council notes the report of the IAEA's, Integrated Regulatory Review Service (IRRS) mission to ARPANSA, which took place 25 June-6 July 2007[3]. The report includes recommendations and suggestions where improvements are necessary or desirable to further enhance the legal and governmental infrastructure for radiation and nuclear safety. One of the suggestions was that ARPANSA should "promote a national system for classification of radioactive waste". Furthermore, the IRRS report recommended that ARPANSA should consider the most effective means to promote this system which would assist the state governments with regulatory oversight of radioactive waste.

Council notes that, in the RHC working group draft, IAEA GSG-1 has been redrafted to put it in an Australian context by removing references to high level waste and nuclear fuel cycle waste (other than U-mining). Some ANSTO-specific references have been included in the 'Origins and types of waste' Annex along with relevant references to other Australian publications, and an expanded table of examples. Attachment 2 to this Report summarises the classification system of GSG-1, as adapted in the RHC working group draft.

Council had discussions with ANSTO and was informed that ANSTO has combined the six international levels of classification for radioactive waste to create a three level system, these being low level waste (LLW), intermediate level waste (ILW) and high level waste (HLW) (Australia does not produce or have any HLW).

Council also noted that the ARPANSA Safety Guide RPS 16 *Predisposal Management of Radioactive Waste* creates six pragmatic categories of existing radioactive waste in Australia, and while the Safety Guide is primarily about predisposal management, the Annexes make comment about appropriate disposal endpoints in each case. Extracts of the statements on disposal from these Annexes are included in Attachment 3 to this report.

6. INVENTORY OF INTERMEDIATE LEVEL RADIOACTIVE WASTE IN AUSTRALIA

6.1 Current information

The inventory provided in the following Sections was reported in Australia's report to the 3rd Review Meeting of the Joint Convention on the Safety of Spent fuel Management and the Safety of Radioactive Waste Management, held in Vienna in May 2009. http://www.arpansa.gov.au/Regulation/Collaborations/jointconv.cfm. A further source of information was the web site of the Department of Resources, Energy and Tourism at

[3]IAEA-NS-IRRS-2007/01 Integrated Regulatory Review Service to The Commonwealth Government of Australia (ARPANSA)

http://www.ret.gov.au/resources/radioactive_waste/radiation_radioactive/Pages/AmountsofRadioactiveWasteinAustralia.aspx.

6.1.1 LLW & short-lived ILW

The estimated inventory for Australian LLW and short-lived ILW of 4020 m^3 is made up of:-

- 2010 m^3 of slightly contaminated soil from ore-processing research;
- 1600 m^3 of operational waste stored at the ANSTO site;
- 390 m^3 of miscellaneous waste including spent sealed sources used in gauges, smoke detectors, medical equipment and luminous signs; and
- 20 m^3 of miscellaneous waste in interim storage at Woomera.

6.1.2 Long-lived ILW

The current estimated inventory of long-lived ILW consists of an approximate waste volume of 535 m^3 currently stored at various locations around Australia [of this amount, about 430 m^3 is under Commonwealth management and the remainder is under State/Territory management]. In most reports on inventory of radioactive waste, the descriptor is in terms of volume. While Council's September 2008 report to the CEO proposed that volume may not be the best descriptor, RET's comments on Council's report note that the volume figure is published on a public information website, is derived from detailed inventory lists, currently under review, which are held by RET. These detailed inventory lists include information on origin, radionuclide and physical form.

This waste is made up of:

- 235 m^3 in the form of reactor target cans, ion-exchange columns, used control arms, aluminium end pieces and some solidified liquid waste;
- 165 m^3 of historical waste in the form of thorium and uranium residues arising from mineral sands processing;
- 135 m^3 of disused sources from medical and research equipment

Using additional information from a range of sources including material published by RET and information provided by States and Territories related to the Joint Convention, the approximate inventory of waste likely to be classified as ILW can be estimated in terms of the activity of radionuclides as presented in Table 1 below.

Table 1: Approximate Inventory of radionuclides likely to be classified as intermediate level waste (ILW)

	States & Territories	Commonwealth	Total (MBq)
Am-241 (MBq)	1.8×10^5	2.5×10^5	4.3×10^5
Am/Be (MBq)	1.0×10^6	2.9×10^6	3.9×10^6
Ra-226 (MBq)	2.0×10^5	5.8×10^5	7.8×10^5
Ra/Be (MBq)	7.7×10^3	-	7.7×10^3
Cs-137 (MBq)	5.2×10^5	1.7×10^5	6.9×10^5
Co-60 (MBq)	1.2×10^6	8.1×10^5	2.0×10^6

6.1.3 Spent Fuel

The only spent fuel currently in Australia is from the ANSTO OPAL reactor and is being held in the reactor service pool prior to being sent offshore for either reprocessing or repatriation. All US origin Spent Fuel from MOATA and HIFAR has been repatriated to the original supplier in the USA and no waste will return to Australia from this fuel. Non-US spent fuel from the MOATA and HIFAR reactors has all been exported for reprocessing and waste from reprocessing is expected to begin to return to Australia from approximately 2015.

6.1.4 ANSTO Waste

Council held discussions with ANSTO regarding their management of radioactive waste. Council was informed on various matters including radioactive waste types, how this waste is processed and conditioned, future developments in the conditioning and disposal of radioactive waste and regulatory issues from an ANSTO perspective.

Other ANSTO waste consists of:

- Irradiated cans from ^{99}Mo production
  ^{60}Co, ^{137}Cs, ^{90}Sr, ^{241}Am;
  14.32 m^3 total volume for disposal
  These small aluminium cylindrical cans contained UO_2 in a quartz structure.
  Note: this process is no longer in use.
- Irradiated Al cut from HIFAR spent fuel
  ^{60}Co, ^{137}Cs; 17.61 m^3 total volume for disposal

- Reactor ion exchange resins
  ^{60}Co, ^{137}Cs, ^{90}Sr, ^{125}Sb; 5.4 m^3 total volume for disposal
- Intermediate level liquid waste (from ^{99}Mo production)
  ^{60}Co, ^{137}Cs, ^{90}Sr, ^{125}Sb, ^{155}Eu, ^{238}U, ^{134}Cs; 1.084 m^3 total volume for disposal
- Other solid waste
  195.79 m^3 total volume for disposal
  This waste typically comprises of gauges and sealed sources used in industry, medical diagnostic and therapeutic sources or devices and small items of contaminated equipment.

6.1.5 General Miscellaneous Waste

Other sources (non-ANSTO) that are expected to be classified as ILW include:

- Am-241 in various radiation gauges; these gauges can detect the thickness of paper, glass and metal foil, as well as being used in a device that detects lead levels in paint. Americium-241 also has a use in fluid level gauges, such as the ones employed in some aircraft fuel gauges.
  - In general the Americium-241 is incorporated in a ceramic enamel, sealed in a welded monel capsule with brazed beryllium window; the active component is recessed into a stainless steel support with tungsten alloy backing.
- Am-241/Be, a mixture of americium-241 and beryllium, which produces neutrons, is used in industrial soil moisture-sensing gauges, pavement density gauges, and for borehole logging systems used in geophysical exploration.
  - Compacted mixture of americium oxide with beryllium metal, doubly encapsulated in welded stainless steel.
- Ra-226, typically needles and tubes from past medical uses, luminous dials and paints;
- The radium cell consists of grains of radium salt, usually sulphate or bromide, mixed with an inactive filler to obtain a uniform radioactive density. These cells are positioned within either needles or tubes depending on the treatment area.
- Ra-226/Be, typically neutron density/moisture gauges;
  - An intimate mixture of $RaCO_3$ and Beryllium powder with a double sheathed monel capsule. Each sheath has a 2 mm wall and is silver soldered.
- Cs-137, typically neutron density/moisture gauges, other gauges and borehole logging sources;
  - Caesium-137 sources housings are normally manufactured from austenitic stainless steel with an inner and outer capsule hermetically sealed by autogenous welding. The caesium-137 can be in the form of an anhydrous caesium chloride crystal or in a ceramic matrix.
- Co-60, typically blood irradiators and industrial sources

- o Cobalt-60 sources are housed in a corrosion resistant stainless steel outer capsule with an inner capsule, both sealed by argon-arc welding. The inner capsule contains nickel plated cobalt metal discs or slugs.

6.2 Future Waste Arisings

It is estimated that Australia will add to its inventory of ILW as follows:

(i) Re-processed Waste

- Approximately 26m^3 of residues from reprocessing of research reactor spent fuel (cemented waste UK) in 53 casks (loaded cask volume 72m^3) is expected to be returned to Australia by 2020.
- Approximately 6m^3 of vitrified glass waste from processing research reactor spent fuel from Areva, France (in two Transnuclear Inc (TN type) casks - loaded cask volume 60 m^3) expected from about 2015.
- Approximately 20m^3 of vitrified glass waste (in TN type casks – loaded cask volume up to 120m^3) from Areva, France expected between about 2020 and 2060.

(ii) *Other Waste*

Waste will include disused sealed sources from medical, industrial and research equipment, target cans, solidified waste from production of radioactive materials used in medicine, conditioned residues from the processing of spent fuel from HIFAR and the OPAL reactors, and the decommissioning of the research reactors (HIFAR & MOATA). It is envisaged that approximately 3.5m^3 of ILW will be produced each year from all sources which includes the Commonwealth, States and Territories.

6.3 Radium Legacy Waste in Australia

A particular category of radioactive waste requiring consideration is that of Ra-226 legacy waste. As Ra-226 is effectively no longer used, Australia's radium waste is primarily held in storage pending a solution to permanently deal with Australia's inventory of Ra-226.

6.3.1 Medical Radiotherapy

Radium was used in Australia for medical radiotherapy treatments in the form of needles, tubes and plates for many years. Activities typically ranged from **0.5mg–10mg** (18.5–370MBq) for needles, **1mg–20mg** (37-740MBq) for tubes and **5mg-50mg** (185-1850MBq) for plates.

The use of radium in medicine was phased out following a recommendation from the National Health and Medical Research Council (NHMRC) in 1976.

The NHMRC:

> "discussed the need to replace radium-226 used for medical purposes in Australia by appropriate substitute radionuclides. It considered the inherent hazard of radium sources and the need to reduce the exposure of persons to ionising radiation to a minimum. It was noted that a potential source of exposure existed in the use of radium-226 in the form of needles, tubes and applicators for medical purposes. Council recommended that the use of radium-226 for those purposes be discontinued as early as practicable and that it be replaced by those artificially produced radionuclides that provide a satisfactory substitute for radium-226."

6.3.2 Commercial Use

Radium was used in luminous dials on clocks, watches, aircrafts dials and compasses. The activities used varied, but some aircraft dials had contact dose rates exceeding 200 µSv/h. Australia's radium waste includes radium paints and dials and contaminated material from luminising.

6.3.3 Neutron Sources

Radium/beryllium neutron sources were used in moisture/density gauges and borehole logging sources. The typical activities for moisture/density gauges were 5 – 10 mCi (185-370 MBq). Several of these sources are in storage in Australia.

6.3.4 Smoke Detectors

Ra-226 was used in early smoke detectors – mainly the commercial/industrial type detectors that were hard-wired into fire protection systems (i.e. not battery operated domestic smoke detectors). Typically up to 100 µCi (3.7 MBq) was used in each detector. There is a large number of these detectors in storage under the control of State and Territory governments.

6.3.5 Estimated Radium Inventory

The following inventory (table 3), arising from the above applications, has been estimated from a range of Commonwealth, States and Territory information provided for input into Joint Convention reports.

Table 3: Inventory of Radium material & sources

	No. of sources	Activity
Luminous material	~80 containers	~300 GBq
Medical – needles, tubes, plates	~2000	~450 GBq
Smoke Detectors	~4600	~0.7 GBq
Ra/Be gauges	~70	~50 GBq
TOTAL	**> 7000**	**~800 GBq**

6.3.6 Long-term Storage of Radium

The long-term storage of legacy radium waste, in the form of both luminous material and radium sources, requires consideration with regard to containment, security, human safety and environmental protection factors.

Council notes that the Australian Report to the Joint Convention Review meeting[4] in May 2009 identified that current arrangements, with storage at many locations throughout Australia, are sub-optimal. The nature of storage of unused radioactive materials at so many sites, some managed by Government but others managed by commercial operators, leads to concern about security and an increased potential for orphan sources to arise.

Other considerations with the long-term storage of radium sources include that radium has a half-life of 1600 years and decays to radon, which is a gas. Hence ventilation of storage areas is important, including filtration of emissions. Contamination by radon decay products is also possible, so conditioning must take account of potential radon emissions. Conditioning and shielding are important as radium and its progeny emit a range of α, β & particularly γ emissions. The gamma dose rate from radium-226 is 223 μSv/h/GBq at 1m. Security for stored radium has an ongoing cost, and given the long half-life, will be a continuing issue for a long time.

7. CONDITIONING & DISPOSAL OF ILW

Council discussions with ANSTO, included details on how ILW was conditioned prior to storage or disposal: these included various methods used by different countries which range

[4] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management – National Report from the Commonwealth of Australia, October 2008 (http://www.arpansa.gov.au/Regulation/Collaborations/jointconv.cfm)

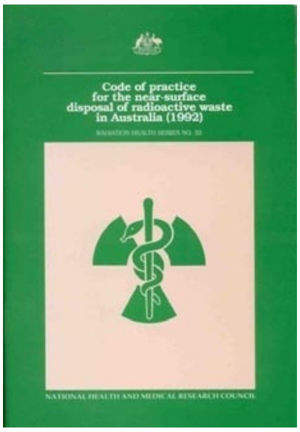
from cement and bitumen to borosilicate glass and ceramics (Synroc), which is an Australian invention. Council noted that the concept of borehole disposal would be possible for some of the ILW in ANSTO's waste. Currently ANSTO conditions LLW, and then stores it in suitable containers within purpose built buildings. ILW is placed in appropriate containment vessels awaiting conditioning based on what decision the government makes with regard to a national/Commonwealth ILW store. Liquid waste from molybdenum-99 production was discussed with the Synroc process emerging as a suitable method to deal with this waste.

Council notes that there are recent developments in terms of conditioning options for sources, including stainless steel containers designed to provide an additional encapsulation for sealed sources. These containers may provide a suitable option for conditioning radium sources.

Council has reviewed options for disposal of radium sources and was advised that in order to meet the Category B limit (5 x 10^5Bq/kg) of the Code of Practice for the near surface disposal of radioactive waste in Australia (1992), and therefore be suitable for shallow ground burial, 1mg radium needle (37MBq) would need conditioning to reduce the activity concentration by a factor of 7.4 x 10^7, which appears to be an impractical level of conditioning for approximately 800 GBq of radium in a near-surface disposal facility.

Council notes a further disposal option, developed by the IAEA for the disposal of small volume disused sealed sources.[5] This is the use of small diameter engineered boreholes (typical diameter 26cm) for disposal of radioactive sources at depths from 30m to several hundred metres. IAEA has developed a Safety Guide (SSG-1) on Borehole Disposal Facilities for Radioactive Waste. The concept includes a generic safety assessment which would:

- identify inventories suitable for disposal
- determine suitable levels of engineering
- determine suitable site characteristics
- determine need for and length of institutional control period
- identify key parameters & extent of site specific assessment



[5] IAEA BOSS: Borehole disposal of Sealed Radioactive Sources.

- examine operational and transport safety

The generic safety assessment indicates that for most radionuclides, including longer-lived radionuclides such as Ra-226, post-closure safety places no limit on the radionuclide inventory that could be disposed of using the borehole disposal concept. Even for radionuclides, such as Pu-238, Pu-239 and Am-241 with exceedingly long half-life daughters (i.e. half-lives in excess of 100,000 years), the concept has the potential to dispose of around 1 TBq in a single borehole.

Hence, even if the more conservative figure of 1 TBq was used as limit on radium activity per borehole, all of Australia's legacy radium inventory of approximately 800 GBq could potentially be disposed of in one borehole of the IAEA SSG-1 design.

8. INTERNATIONAL GUIDANCE

Council considered a range of international documents, and in particular a number of recently published and draft IAEA Safety Standards, along with summaries of approaches taken in other comparable countries.

It is clear that Australia does not need to create original guidance material as a great deal has been produced internationally, but adaptation may be required to make this guidance relevant for Australian needs. It is important to note that Australia is represented on many IAEA committees dealing with these issues. The IAEA draft document SSR-5 (DS354) *Disposal of Radioactive Waste* sets out the requirements for radioactive waste management, and is supported by a range of Safety Guides including SSG-1 *Borehole Facilities for the Disposal of Radioactive Waste*, GSG-1 *Classification of Radioactive Waste*, and draft DS334 *Geological Disposal of Radioactive Waste*. There are a range of other IAEA documents in the waste safety series.

Council also noted that other agencies, such as NEA published guidance material on radioactive waste issues, including *Disposal of Radioactive Waste in Perspective* (2009).

Further information on international best practice and trends in radioactive waste management overseas can be found in the country reports to the 3rd Review Meeting of Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management (May 2009) and the outcomes of the review meeting. Council used the Australian Report to the review meeting to obtain information for this report, and noted some relevant outcomes of the meeting, including identifying countries developing or implementing a National Radioactive Waste Management Plan by bringing together all planning of the future storage and disposal of waste under a single national radioactive waste organisation as being a good practice. Other outcomes included noting the activities undertaken in some countries to develop or maintain a skilled workforce, and the importance of stakeholder involvement to help find volunteer communities to host facilities. Council also noted that there was widespread concern about the need to identify, recover and manage orphan sources due to the security risks posed.

In regard to Australia's report, good practices identified were: (1) the strong commitment of ARPANSA to peer review - the International Regulatory Review Service mission to ARPANSA in 2007 was cited; (2) the ANSTO study of distribution and migration of radionuclides at the Little Forest Burial Ground which has been accepted as a case study for the IAEA Environmental Modelling for Radiation Safety project; (3) the introduction of the graduate recruitment program at ARPANSA to address staffing issues; (4) the active role Australia plays in promoting radioactive waste safety and sealed source security on a regional basis, including promotion of the Joint Convention. The rapporteur's report noted that Australia has challenges in: (1) establishment of facilities for long term radioactive waste management; (2) contingency planning for storage of returned intermediate level reprocessing waste; (3) remediation of legacy mining sites; and (4) maintaining appropriate levels of skill and expertise in regulatory bodies and operators.

Council also discussed information from outcomes of relevant international conferences. In particular, the *International Workshop on Disposal of Radioactive Waste at Intermediate Depth: The Safety Basis and its Realization* held in Gyeongju City, Republic of Korea, 8-12 December 2008, discussed approaches to disposal of ILW. The findings of the Workshop showed that commensurate with the diverse range of ILW, a diverse range of disposal solutions have been implemented and proposed. Examples are: relatively shallow cavities, former mines, disposal in bedded salt formations, borehole disposal solutions and near surface disposal facilities adapted to particular waste streams. Council noted that Depth of disposal is just one of the factors that must be considered for the safety of ILW disposal: the properties of the geological environment, the waste characteristics and engineered features of the facility, regulatory constraints, national policy, are other factors of equal or greater importance.

Of particular interest was that the findings included "Some form of borehole disposal may be appropriate for ILW disposal – for countries with small waste volumes but in other countries as well. It should be noted that the IAEA concept for borehole disposal is limited to disposal of disused sealed radioactive sources in small diameter boreholes and subject to a generic safety assessment. Other borehole type disposal could be used for ILW disposal but would require a facility-specific safety case".

9. GOVERNMENT POLICY

The pathway to develop a radioactive waste management facility is complex and requires political agreement to ensure that it can be realised. To date considerable effort has been put into identifying sites and developing proposals for a facility, without a successful outcome.

Council held discussions with the Manager, Radioactive Waste Management Section, Department of Resources Energy and Tourism (RET) in December 2009. RET's responsibility for radioactive waste management under the Administrative Arrangement Order was discussed. Council understands RET's role includes program and policy functions, participation in the joint NT-Commonwealth Rum Jungle Management Committee, administration of former British nuclear test sites in Australia until the hand-back to the Maralinga Tjarutja people in December 2009 and the defence of common law actions arising from British nuclear test programs.

Council believes that there needs to a better understanding of the scientific basis of radioactive waste management in political discussion and decision making. Consideration needs to be given as to how this can be achieved.

As previously noted, the National Radioactive Waste Management Bill 2010 was introduced to the Australian Parliament on 24 February 2010.

9.1 The Need For a National Radioactive Waste Strategy

Council understands that the general strategy for the management of Australia's radioactive waste has been to establish a facility for near surface disposal of LLW, and to indefinitely store ILW.

Council believes that it is important that Government policy and strategy for radioactive waste management should consider developments in international best practice, and in particular the guidance published in safety standards published by the IAEA. Council is mindful that Australia participates in the IAEA committees involved in developing these international safety standards.

A knowledge of what constitutes international best practice can be ascertained from drawing together statements from various key IAEA publications:

The IAEA Safety Fundamentals publication Fundamental Safety Principles[6] sets out the fundamental safety objective and safety principles that apply for all facilities and activities in radioactive waste management, including the disposal of radioactive waste. The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation. A further principle is that people and the environment, present and future, must be protected against radiation risks. Requirements for establishing a national system for radioactive waste management are established in IAEA Safety Requirements GS-

[6] IAEA, SF-1, Fundamental Safety Principles, 2006

R-1 *Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety*, including:

> "6.7......Consequently, national policies and implementation strategies for the safe management of radioactive waste shall be developed, in accordance with the objectives and principles set out in the IAEA Safety Fundamentals publication on The Principles of Radioactive Waste Management....."

In identifying responsibilities for radioactive waste management, a new IAEA draft requirements document SSR-5 (DS354): *Disposal of Radioactive Waste* (currently before the IAEA Board of Governors) specifies Government responsibilities as:

> **"Requirement 1: The government is required to establish and maintain an appropriate governmental, legal and regulatory framework for safety within which responsibilities are clearly allocated for disposal facilities for radioactive waste to be sited, designed, constructed, operated and closed. This shall include: confirmation at a national level of the need for disposal facilities of different types; specification of the steps in development and licensing of facilities of different types; and clear allocation of responsibilities, securing of financial and other resources, and provision of independent regulatory functions relating to a planned disposal facility."**

This requirement derives from a principle established in the IAEA Fundamental Safety Principles (SF-1). It is also stipulated under the terms of the Joint Convention.

In addition, SSR-5 includes concepts relating to disposal (and storage) of radioactive waste. SSR-5 defines 'disposal' as the emplacement of radioactive waste into a facility or a location with no intention of retrieving the waste. The term disposal implies that retrieval is not intended; it does not mean that retrieval is not possible. By contrast, 'storage' refers to the retention of radioactive waste in a facility or a location with the intention of retrieving the waste. SSR-5 identifies the important difference that storage is a temporary measure following which some future action is planned. This may include further conditioning or packaging of the waste, and ultimately its disposal.

Hence, the overall picture of international best practice is that countries should have a policy and strategy for management of radioactive waste, in which storage has a legitimate temporary role provided there is a further strategy for ultimate disposal of the waste. This also leads to the conclusion that Australia's current policy of indefinite storage for intermediate level waste does not appear to be consistent with international best practice.

In developing a national strategy it is necessary to ensure an appropriate infrastructure is in place to manage radioactive waste. Council noted that in some countries, this has been achieved by establishing a radioactive waste management organisation.

Typically, a national strategy would include elements such as:

- Analysis of present and likely situations regarding radioactive waste;
- Options for managing radioactive waste;
- Responsibility and funding;
- Radioactive waste management system;
- Legal framework;
- Return to supplier;
- Discharge/disposal;
- Security.

Australia will need to consider how a radioactive waste management strategy would be implemented and funded to ensure that outcomes are achievable.

In terms of the types of waste management options being considered, in its September 2008 Report, Council noted the possibility of co-location of a facility for disposal of LLILW with any intermediate level waste (ILW) storage facility or low-level waste (LLW) repository. Council considers that, if the geological circumstances are appropriate, it would be sensible to explore co-locating intermediate depth disposal techniques such as boreholes, with an ILW store and/or shallow ground burial facility for LLW. Council understands that for a particular site, there are many factors that would need to be thoroughly examined, including geology and groundwater levels, before co-location could be undertaken.

9.2 Communicating on the Safety of Radioactive Waste Disposal

Lessons learned from the early years of radioactive waste disposal discussions internationally, are that it is difficult to make progress with the development of radioactive waste repositories without involving those who may be affected in the decision-making process at an early stage. Several experiences of how the communications with affected parties have been managed in national projects have been described during international conferences and workshops[7]. It is now generally recognised that openness, trust and participation are all essential for communication and stakeholder involvement on radioactive waste. The importance of using all available approaches and techniques for communication should not be underestimated.

[7] Safety of Radioactive Waste Disposal: Proceedings of an International Conference held in Tokyo, 3-7 October 2005, International Workshop: Intermediate Depth Disposal of Radioactive Waste, Gyeongju, Korea, 8-12 December 2008, Disposal of Low Activity Radioactive Waste: Proceedings of an International Symposium held in Cordoba, 13-17 December 2004, Issues and Trends in Radioactive Waste Management Proceedings of an International Conference held in Vienna, 9-13 December 2002

Strong, transparent regulatory oversight of the highest order is required to provide public confidence that any health, environmental and social issues in radioactive waste management are being addressed.

10. TYPE OF REGULATORY OR OTHER GUIDANCE REQUIRED

Council considers it essential that advances in international guidance in radioactive waste management be incorporated in the development of Australia's regulatory requirements and guidance material. The IAEA has produced a range of relevant safety standards and guidance that should be considered in this process.

As described in section 9.1 of this report, relevant IAEA publications establish the need for a national policy and strategy for radioactive waste management, including ultimate disposal. Council noted State and Territory Governments also regulate the disposal of radioactive material within their jurisdiction.

As previously noted, Council in its September 2008 report recommended:

> "ARPANSA should develop regulatory guidance on the management and disposal of LLILW, including guidance for applicants proposing to establish a waste management facility. Guidance should also be developed on how applications for such facilities will be assessed."

While noting that ARPANSA does have some regulatory guidance, it should be reviewed and if necessary revised to ensure that it is up to date and consistent with international best practice.

Council considers it important that, in the cases of sources, users be required to identify their disposal strategy at the time of applying for licence. This could be addressed in either regulatory or other guidance documents.

The key document in Australia for disposal of low level waste (LLW) and short-lived intermediate level waste (SLILW) is the NHMRC *Code of Practice for the Near Surface Disposal of Radioactive Waste in Australia* (1992), published as Radiation Health Series 35 (RHS 35). Given that this Code was published in 1992 and that a considerable number of IAEA Requirements and Safety Guides have been updated and published in the intervening 18 years, Council considers that RHS 35 should be reviewed and if necessary, revised to ensure that it continues to reflect international best practice. Council notes that in relation to institutional control, the clarification of responsibility for pre-closure and post-closure monitoring, and the preservation of records of waste disposal after the period of institutional control has ceased are important considerations which need to be addressed.

Council discussed new developments in radioactive waste management internationally, including the recent publication of IAEA SSG-1 Safety Guide: *Borehole Disposal Facilities for Radioactive Waste,* which sets out a system for the disposal of ILW at intermediate depth in small diameter boreholes. Council considers that this option should be explored in any proposal for disposal of Australian ILW, as it appears to be a cost-effective means of disposal for at least some of Australia's ILW inventory, such as radium legacy waste and disused sealed sources.

An important area requiring further guidance is that of waste acceptance criteria. Council notes that development of waste acceptance criteria will necessitate site-specific considerations. Development of generic acceptance criteria may assist waste generators and enable them to start preparation and conditioning of waste, even though some additional work may be required at a later stage to account for site-specific criteria. Council believes that the feasibility of generic acceptance criteria and the development of national guidance on conditioning of radioactive waste should be further investigated.

11. COUNCIL RECOMMENDATIONS

As a result of this scoping review, Council considers work should commence in a number of areas to support a decision of Government. Council makes the following three recommendations in accordance with the terms of reference:

Types of ILW and Inventory:

1. That the CEO of ARPANSA discuss with relevant Commonwealth Government bodies and State and Territory Regulatory bodies the need for all jurisdictions to undertake an audit of radioactive waste currently in storage, both within government controlled facilities and in other locations.

Types of Regulatory Guidance:

2. That the CEO of ARPANSA commence a review, and if necessary revision, of the NHMRC *Code of Practice for the Near Surface Disposal of Radioactive Waste in Australia* (RHS 35) 1992, to ensure that it is consistent with current international best practice in radioactive waste management.

3. That the CEO of ARPANSA develop regulatory guidance relevant to the use of borehole disposal for suitable types of intermediate level waste, using the IAEA Safety Guide SSG-1 as an indicator of international best practice.

Other matters for consideration:

In preparing this report, Council discussed a wide range of radioactive waste management matters, and as a result identified several areas that may require further consideration.

Council noted that these were not necessarily matters that were directly under ARPANSA's control, and were not necessarily within the terms of the current scoping review. Council considers these to be important areas for progressing radioactive waste management in Australia, and recommends that the CEO of ARPANSA give further consideration to the following matters:

1. Collaboration with relevant Government agencies to develop a national strategy for radioactive waste management, including a system to maintain an ongoing inventory of waste and a strategy for its ultimate disposal.
2. Strategies that could be used to improve the understanding by political decision-makers of scientific issues related to radioactive waste management.
3. Strategies to ensure effective and timely communication and involvement of stakeholders in consideration of proposals and/or licence applications on radioactive waste management.
4. Development of generic waste acceptance criteria and national guidance on conditioning of waste to assist waste generators in preparing for future disposal options. Site-specific waste acceptance criteria would also need to be developed for any proposal to establish a waste management facility.
5. Institutional control – clarification of responsibility for pre-closure and post-closure monitoring.
6. Preservation of records of waste disposal after the period of institutional control has ceased.
7. Principles around financial arrangements to ensure that radioactive waste management strategies can be achieved.

Preliminary Recommendations from September 2008:

Council also endorses the preliminary recommendations of the previous Council's report dated September 2008:

1. The feasibility of intermediate depth disposal for the different types of LLILW in Australia should be further investigated. For example, borehole disposal may be suitable for radium legacy wastes and a range of disused sealed sources, and should be examined in more detail.
2. Opportunities for international collaborations should be investigated by both ARPANSA and waste facility operators to enhance Australia's expertise in radioactive waste management, safety assessment, development of waste acceptance criteria and regulation of radioactive waste management facilities.
3. ARPANSA should develop regulatory guidance on the management and disposal of LLILW, including guidance for applicants proposing to establish a waste management facility. Guidance should also be developed on how applications for such facilities will be assessed.

REFERENCES USED IN PREPARING THIS REPORT

ARPANSA 2008, Safety Guide on Predisposal Management of Radioactive Waste (RPS 16)

Australian Government 2008, Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management – National Report from the Commonwealth of Australia, (Report to 3rd Review meeting (May 2009))

Australian Ionizing Radiation Advisory Council 1979, Radioactive Waste Management, (AIRAC No. 6)

Environment Protection Authority SA, *Audit of Radioactive Material in South Australia*, September 2003.

IAEA 1988, The Radiological Accident in Goiania, September 1988

IAEA 2000, Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, (GS-R-1)

IAEA 2003, Predisposal Management of Low and Intermediate Level Radioactive Waste, (WS-G-2.5)

IAEA 2006, Fundamental Safety Principles, (SF-1)

IAEA 2006, Storage of Radioactive Waste, (WS-G-6.1)

IAEA-NS-IRRS-2007/01 Integrated Regulatory Review Service to the Commonwealth Government of Australia (ARPANSA)

IAEA 2009, Draft Safety Requirements – Disposal of Radioactive Waste SSR-5 (DS354)

IAEA 2009, Borehole Facilities for the Disposal of Radioactive Waste, (SSG-1)

IAEA 2009, Classification of Waste, (GSG-1)

IAEA 2009, draft Geological Disposal of Radioactive Waste, (DS334)

IAEA 2009, draft Safety Assessment of Radioactive Waste Disposal Facilities, (DS355)

NHMRC 1992, Code of Practice for the Near Surface Disposal of Radioactive Waste in Australia, (Radiation Health Series 35)

NEA 2009, Disposal of Radioactive Waste in Perspective

RHSAC 2002, Council advice to the CEO on Radioactive Waste, December 2002, http://www.arpansa.gov.au/publications/rhsac/rhsac_stat.cfm#rad

RHSAC 2004, Council Advice on an Indicator of Sustainable Development for Radioactive Waste, April 2004, http://www.arpansa.gov.au/publications/rhsac/rhsac_stat.cfm#rad

RHSAC 2008, Advice to the CEO of ARPANSA – Management and Disposal of Long-Lived Intermediate Level Waste (LLILW), September 2008

<u>ATTACHMENT 1:</u> Summary of State/Territory and Commonwealth activities on disposal of radioactive waste

State/ Territory	Current arrangements	Details of activities in progress or Planned activities
ACT	There is a small waste store that holds a range of radioactive waste collected over many years. This store is currently full and no further waste is being added to the store.	Nil
NSW	There is a non-operational store for radioactive materials collected from the community, hospitals, industry and educational institutions in New South Wales. Security arrangements for this store have been significantly upgraded over the last two years	Nil
NT	The current storage facility for radioactive waste generated in the Northern Territory is a secure room at Royal Darwin Hospital.	Nil
QLD	The purpose-built radioactive waste facility owned by the Queensland State Government is a store only. The facility is located in South East Queensland, in the Shire of Esk.	Nil
SA	SA does not currently have a central store or repository for radioactive waste generated within its jurisdiction. Radioactive wastes resulting from industrial, scientific, medical and other uses of radioactive material are stored in numerous small scale facilities that are the responsibility of the owner.	In South Australia, options for the establishment of a interim store and repository for low level and intermediate level radioactive waste at approved sites are being investigated. In December 2005, the South Australian Government announced its intention that an interim store and repository would be located in the Olympic Dam region. The facilities would be outside the Olympic Dam uranium mine lease area.
TAS	There is a small store operated by the Tasmanian government for waste generated in Tasmania. Other storage facilities are all small scale and operated by licence holders.	An audit of all radioactive waste will be conducted in due course. The storage location for radioactive materials under Tasmanian government control has been further upgraded and complies with relevant requirements.
VIC	There is an Interim Storage facility for radioactive materials seized and abandoned in Victoria.	Nil
WA	Western Australia has the Mt Walton East Intractable Waste Disposal Facility for the	At the Mount Walton East Intractable Waste Disposal Facility in Western

	permanent disposal of intractable (chemical and radiological) waste generated within Western Australia. This facility lies about 75km northeast of Koolyanobbing and approximately 53km north of Jaurdi Station homestead. The Western Australian regulator operates a radioactive waste store. The store is situated on the Queen Elizabeth II (QEII) Medical Centre Site. The store's main purpose is for interim storage of radioactive substances that have no further use prior to disposal at Mt Walton East. A recent disposal campaign was carried out.	Australia, the category of waste that can be disposed of and the activity limits are as outlined in the *Code of Practice for the Near-Surface Disposal of Radioactive Waste in Australia* (NHMRC, 1992). Following a review of international documents in 2007, additional restrictions were placed on the acceptance of some sources for burial in the 2008 disposal campaign, with the Radiological Council committing to a further review prior to the next campaign.
CWLTH	ANSTO manages wastes arising from its research reactor operation, radio-isotope production and research activities according to nationally and internationally accepted criteria. ANSTO is taking steps to condition waste and reduce volumes by releasing decayed material that is below exemption criteria and by super-compaction of some drummed low-level waste. ANSTO operates several facilities for managing liquid and solid radioactive waste arising from its routine operations. ANSTO's storage facilities are considered to be for medium-term storage. ANSTO also has responsibility for a disposal facility called the Little Forest Burial Ground, which is a secure, shallow land burial site used by the former Australian Atomic Energy Commission for the disposal of some wastes (both radioactive and non-radioactive) up until 1968. The Australian Radiation Protection and Nuclear Safety Agency operates a small waste store located at its Yallambie, Victoria premises. The Commonwealth Scientific and Industrial Research Organisation has a number of small stores for waste at its laboratories around Australia. Stores for Commonwealth radioactive waste are located on the Woomera Prohibited Area, Woomera, South Australia.	Australia's national government changed following the November 2007 federal election. The new Commonwealth government is presently reviewing all aspects of its long-term radioactive waste management strategy.

The information in this Attachment is derived from Australia's National Report to the 3rd Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management in May 2009. The material was current in late 2008. For both ACT and SA, there was no information on current arrangements in the Joint Convention National Report. The information for current arrangements in SA and ACT was provided by the jurisdictions in late 2009 for the development of Council's report.

<u>ATTACHMENT 2:</u> Summary of Classification System from RHC Draft Radiation Protection Series document – Recommendations for the Classification of Radioactive Waste

Classification	How it is classified	How it can be managed
Exempt Waste (EW)	• small concentrations of radionuclides disposed of in conventional landfills or recycled • exempt from regulatory control.	• treated as regular, non-radioactive waste • does not require provisions for radiation protection
Very Short Lived Waste (VSLW)	• radionuclides of very short half-life (generally 100 days or less) • activity concentrations above the exemption levels.	• stored until the activity concentration has fallen beneath the exemption levels, then reclassified as EW and disposed of.
Very Low Level Waste (VLLW)	• levels of activity concentration in the region of or slightly above the exemption levels • naturally occurring radionuclides originating from the mining and processing of ores and minerals	• disposed of in engineered surface landfill type facilities • range from simple covers to more complex disposal systems • disposal systems require active and passive institutional controls • other management options may include the authorised use of this material (e.g. for road construction).
Low Level Waste (LLW)	• suitable for near surface disposal • ranges from waste with an activity content just above VLLW to waste that requires shielding, containment and isolation for limited periods of time up to a few hundred years is required • wide range of activity concentrations; wide range of radionuclides • can also contain low concentrations of long lived radionuclides • account should be taken of exposure pathways including ingestion and inhalation.	• near surface disposal • ranges from simple to more complex engineered facilities at varying depths • from the surface down to 30 metres • include trenches, vaults or shallow boreholes

Intermediate Level Waste (ILW)	• contains long lived radionuclides in quantities that need a greater degree of containment and isolation from the biosphere than provided by near surface disposal.	• engineered facilities at intermediate depths between a few tens of metres and several hundred metres (including existing caverns) and disposal in boreholes of small diameter.
High Level Waste (HLW)	• large concentration of both short and long lived radionuclides • a greater degree of containment and isolation than ILW • generates significant quantities of heat from radioactive decay for several centuries.	• Australia has no HLW and is unlikely to have any in the foreseeable future. • No further coverage in the proposed Recommendations.

<u>ATTACHMENT 3:</u> Extracts from RPS 16: Safety Guide for Predisposal Management of Radioactive Waste

The following are extracts from the Annexes of RPS 16 highlighting the paragraphs on disposal methods for each category of waste:

Annex A: Management of Devices Containing Low Levels of Long-Lived Alpha Emitters (Dials and Luminous Devices and Smoke Alarms)

The low level of radioactivity in each luminous device and smoke alarm means they should be acceptable for disposal in a near-surface disposal facility.

Annex B: Management of Devices containing Higher Levels of Long-Lived Alpha Emitters (Radium Needles and Tubes, Neutron Sources)

Waste items containing higher levels of long-lived alpha emitters (including radium needles and tubes and neutron sources) are an intermediate level radioactive waste. The combination of long half-life and high radioactivity concentration is likely to make these items unsuitable for near-surface disposal. Hence waste containing higher levels of long-lived alpha emitters is likely to need storage until a deep borehole or other geological waste disposal facility is established.

NB: By keeping package diameters to 100 mm or less gives confidence that the waste will be able to be disposed of in almost any borehole facility.

Annex C: Management of Disused Sealed Sources of Low Radioactivity (<100MBq) and Gaseous Tritium Light Sources

A near-surface repository may be licensed to accept sealed sources of particular radionuclides and below a specified radioactivity level. The limits on low radioactivity sources at a disposal facility should be based on the post closure safety case submitted in support of the disposal facility licence and the licence conditions imposed by the regulator.

Most low radioactivity (<100 MBq) disused sources are likely to be accepted at a near-surface disposal repository. Also likely to be accepted are short-lived and medium-lived disused sources that will decay to insignificant levels within the institutional control period of the repository. Medium-lived sources of higher radioactivity and long-lived sources are likely to require deeper disposal, such as a deep borehole or other geological facility.

Annex D: Management of Disused Sealed Sources of Higher Radioactivity (>100MBq)

Sealed sources of higher activity present a particular problem for disposal because the radioactivity in the source exists in a very concentrated form and the source might maintain its integrity beyond the institutional control period of a repository.

Short-lived sources containing even high levels of radioactivity could be suitable for near-surface disposal if they decay to insignificant levels during the institutional control period of the disposal facility. Very short-lived sources could be stored until the level of radioactivity is less than exemption levels.

Medium and long-lived disused sources containing higher levels of radioactivity are an intermediate level radioactive waste unsuitable for near-surface disposal. Much of this waste will have to be stored until a geological waste disposal facility, such as a borehole facility, is established.

Annex E: Management of Laboratory and Medical Waste

Most laboratory and medical radioactive wastes have a sufficiently low radionuclide concentration to be accepted at a near-surface disposal facility.

Other disposal options include delay/decay to below exemption levels for clearance or disposal are to be developed in accordance with a Schedule of the NDRP (ARPANSA 2004).

Annex F: Management of Residues from Industrial Processing and Waste from Remediation of Contaminated Sites

Most bulk radioactive wastes that occur as residues from industrial processes or from remediation of contaminated sites have a sufficiently low radionuclide concentration to be accepted at a near-surface disposal facility, or a facility that meets the criteria for a near-surface activity. If there are large volumes of waste, consideration should be given to establishing such a facility close to the source of the waste, to minimise transport costs.

In the oil and gas industry, consideration should be given to injecting scale contaminated with naturally occurring radioactivity down a well with recharge water where it can be demonstrated that there is no likelihood of the well ever being used again for extraction. This returns the radioactivity back to the geological depths from which it came and isolates the radioactivity from humans and the environment.

ATTACHMENT 4: List of Discussion Participants

Mr Keith Dessent, Standards Development & Committee Support Section, ARPANSA

Mr Stuart Woollett, Environmental Impact Assessment Section, ARPANSA

Dr Adi Paterson, Chief Executive Officer, ANSTO

Dr Ron Cameron, then Executive General Manager, Strategy, Government and International Relations, ANSTO

Mr Lubi Dimitrovski, Manager, Waste Operations & Technology Development, ANSTO

Mr Patrick Davoren, Manager, Radioactive Waste Management Section, Department of Resources, Energy and Tourism