# 7. Current Status on Decommissioning/Clearance in Australia

## 7.1 Concept and Strategy for RWM

### 7.1.1National Policy

Australia has a federal system of government and the regulation of radioactive waste management and disposal comes under both Commonwealth (federal) and State/Territory regulation. Nuclear activities and uses of radiation and radioactivity by federal agencies are regulated by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). This includes regulating the management and storage of radioactive waste at federal agencies such as the Australian Nuclear Science and Technology Organisation (ANSTO), the Commonwealth Science Industry and Research Organisation (CSIRO), and the Department of Defence.

In the States and Territories, the use of radiation and radioactivity is regulated by Environmental Protection Authorities and Health Departments in each state unless it arises from the activities of a Commonwealth agency, in which case it is regulated by ARPANSA. ARPANSA is also tasked with promoting uniformity of radiation protection and nuclear safety policy and practices (including radioactive waste management) across all jurisdictions (Commonwealth, the States and Territories).

Radioactive waste in Australia is generated by research, industry, medical applications, research reactor operation (at ANSTO, Lucas Heights) and radiopharmaceutical production. Australia is developing an integrated waste management strategy for the long-term management of this radioactive waste. For radioactive waste produced by Australian Government agencies, Australia is establishing a near-surface repository for disposal of low level and short-lived intermediate level radioactive waste, and a store for the storage of intermediate level radioactive waste. Australia has no nuclear power plants. Current policy requires that each state and territory is responsible for the management of radioactive waste generated within their jurisdictions.

The mining of uranium in Australia produces large quantities of wastes containing elevated levels of naturally-occurring radionuclides. Two uranium mines now operating produce about 10 million tonnes of uranium mill tailings a year (Olympic Dam mine 9.1 Mt in 2001, Ranger mine 1.8 Mt in 2000/01) and these tailings are managed at the mine sites. At the Olympic Dam mine in SA, the coarse fraction of tailings is used underground as backfill, and the fine tailings material still containing potentially valuable minerals (rare earths, etc.) is emplaced in tailings dams. At the Ranger mine in NT, tailings were emplaced in an engineered dam on the lease until 1996, but are now all deposited into a worked-out pit. Although uranium mill tailings are controlled by different regulations, the requirements for their disposal are consistent with criteria for near-surface disposal of radioactive wastes.

Technologically-enhanced naturally-occurring radioactive materials (NORM) are also produced by mineral sands operations, tantalum mining, tin and copper smelting, alumina production and in fossil-fuel use including scale from oil and gas production. In general, mining wastes are dealt with at the mine sites and are regulated under mining regulations.

The UN Joint Convention on The Safety of Spent Fuel Management and the Safety of Radioactive Waste Management was ratified by Australia in August 2003. The Joint Convention applies to spent fuel and radioactive waste resulting from civilian nuclear reactors and applications. Wastes from the mining and milling of uranium ores are subject to the Joint Convention. However, the Convention does not apply to waste that contains only naturally-occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it is declared as radioactive waste for the purposes of the Convention by Australia as a Contracting Party. Wastes containing only naturally-occurring radioactive materials that do not originate from the nuclear fuel cycle have not been declared as radioactive waste by Australia for the purposes of the Convention.

The obligations of Australia, as a Contracting Party, with respect to the safety of spent fuel and radioactive waste management are based to a large extent on the principles contained in the IAEA Safety Fundamentals document "The Principles of Radioactive Waste Management", published in 1995.

### 7.1.2 Criteria for Radioactive Waste Management

In Australia, there is currently no overall unified classification system for radioactive waste. However, for practical purposes radioactive waste is classified into five different categories, Very Low Level, A, B, C and S. The latter four categories are defined in the *Code of practice for the near surface disposal of radioactive waste in Australia (1992)*1.

Three categories of radioactive waste (A, B and C) are defined in the Code as suitable for near-surface disposal and one category (S) as unsuitable. The generic concentration limits for these categories are listed in Table 1. These activity limits are provided for a remote and arid site where groundwater pathways for release of radionuclides are insignificant and could be ignored, and were derived from an evaluation of potential intruders such as road construction, house building, residential use, livestock grazing and archaeological excavation scenarios which might arise after the institutional control period.

**Table 1**: Generic Concentration Limits for Disposal of Radioactive Wastes at an Arid Remote Site

| **Radionuclide** | **Category** | **100 y control Bq/kg** | **200 y control Bq/kg** |
|---|---|---|---|
| Tritium | Category A | $5 \times 10^{8}$ | $10^{11}$ |
| | Category B & C | $10^{10}$ | $5 \times 10^{12}$ |
| Carbon-14 | Category A | $10^{7}$ | $10^{7}$ |
| | Category B & C | $5 \times 10^{7}$ | $5 \times 10^{7}$ |
| $\alpha$-emitters | Category A | $10^{5}$ | $10^{5}$ |
| (inc. $^{238}U$, $^{239}Pu$, $^{241}Am$) | Category B & C | $10^{7}$ | $10^{7}$ |
| Ra-226, U* | Category A | $5 \times 10^{3}$ | $5 \times 10^{3}$ |
| Ra-226 | Category B | $5 \times 10^{5}$ | $5 \times 10^{5}$ |
| Ra-226, Th-232, U* | Category C | $5 \times 10^{5}$ | $5 \times 10^{5}$ |
| $\beta/\gamma$ emitters with | Category A | $5 \times 10^{5}$ | $5 \times 10^{6}$ |
| half-life > 5 y | Category B & C | $10^{8}$ | $10^{9}$ |
| $\beta/\gamma$ emitters with | Category A | $10^{9}$ ** | $10^{9}$ ** |
| half-life = 5 y | Category B & C | no limit** | no limit** |

Note

* Is uranium in secular equilibrium with progeny

** In practice consideration of surface dose rates from waste packages during transport and handling will lead to more restrictive values.

*Categories A, B and C – low level and short-lived intermediate level waste*

Radioactive waste classified as Category A, B or C is low level or short-lived intermediate level radioactive waste, according to the classifications found in the IAEA *Safety Guide on the Classification of Radioactive Waste*. The NHMRC Code defines Category A, B and C waste is suitable for near-surface disposal.

*Category S – long-lived intermediate level waste*

Radioactive waste classified as Category S is long-lived intermediate level radioactive waste, according to the classifications found in the IAEA *Safety Guide on the Classification of Radioactive Waste*. Category S waste is not suitable for disposal in a near-surface repository, but can be safely stored in a purpose-built, above-ground store.

ARPANSA regulations define exemption values for all radionuclides which are based on the IAEA Basic Safety Standards. At this time, the States and Territories have inconsistent definitions as to what constitutes a radioactive substance, but are working towards a uniform standard through the recently implemented National Directory for Radiation Protection.

### 7.1.3 Clearance Processes

The IAEA Safety Guide, Application of the Concepts of Exclusion, Exemption and Clearance, IAEA Safety Standard Series RS-G-1.7, Vienna (2004) gives guidance in the application of the principles of exemption and clearance and sets radionuclide specific clearance levels for bulk solid materials intended for unrestricted disposal.

Exemption of material from regulatory control is addressed in federal and state legislation in Australia. At the federal level, exemption limits for radionuclides are defined in the *Australian Radiation Protection and Nuclear Safety Regulations (1999).* These limits are largely consistent with limits given in the International Atomic Energy Agency, International Basic Safety Standards for Protection Against Ionising Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

At the state or territory level, separate regulations define the exemption limits applicable for each state or territory. In New South Wales, the *Radiation Control Regulation 2003 (NSW)* defines the criteria for classification of material as radioactive substances. To attain uniformity in regulatory control in radiation safety amongst the various Australian jurisdictions, a common non-legislative standard for radiation protection entitled the *National Directory for Radiation Protection* has been recently introduced (ARPANSA, Radiation Protection Series Publication No. 6: National Directory for Radiation Protection Edition 1.0, August 2004

All these regulatory schemes establish exemption limits for radionuclides, but do not specify radionuclide specific clearance limits for solid waste. The NSW Department of Environment and Conservation (DEC) - formerly the Environmental Protection Agency (EPA) - has issued guidelines for classification of waste for ultimate disposal in New South Wales landfills (EPA NSW, Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Waste, 1999). ANSTO has established criteria for releasing waste for unconditional disposal based on these laws and IAEA safety standards.

## 7.2Case Study on Decommissioning/Clearance

### 7.2.1Decommissioning

#### 7.2.1.1Nuclear Reactors

There are currently two nuclear facilities being decommissioned in Australia. Both are former research reactors operated by the Australian Nuclear Science & Technology Oragnisation (ANSTO) located in Sydney.

- The 100 kW Moata research reactor was shut down in May 1995, and the fuel, the cooling system and electric systems removed. The spent fuel has since been shipped to the US. A decommissioning plan has been prepared and agreed to by the regulator. Planning for final decommissioning has commenced and it is anticipated that decommissioning will be completed within 3 years.
- The 10 MW HIFAR was shut down in January 2006 and a decommissioning strategy is currently being put in place with the Australian regulator ARPANSA. The total cost of the process is estimated to be around $50 million.

It is an internationally accepted practice to have generally a number of distinct stages leading to the decommissioning of a reactor facility, as defined in IAEA Standards and Guides. These stages comprise of defined transitional stages from final shutdown to decommissioning as described below.

*Stage 1*, when the reactor is permanently shutdown, the fuel is removed, the fluids are drained from the facility and external materials can be disconnected or removed.
*Stage 2*, the care and maintenance stage, where a state of monitoring and maintenance is maintained until the documentation and arrangements are in place for the third stage.
*Stage 3*, the decommissioning, covers the entire decommissioning process including the removal of all radioactive and other wastes.
*Stage 4*, the final stage called the unrestricted site use and refers to when the site is permitted to return to a “green field” site or used for other purposes without restrictions being imposed.

Research reactors that have been completely dismantled within ten years of de-fuelling include the Omega West reactor at Los Alamos (US), the Japanese Power Demonstration reactor and the Georgia Tech reactor (US). Decommissioning within ten years of de-fuelling is also planned for the DR3 at Risø (Denmark), and the University of Michigan reactor (US). This prompt decommissioning approach has generally been adopted because it relieves future generations of the responsibility for handling the facility, reassures stakeholders that the facility will be dismantled and maximises use of experienced staff in the decommissioning process.

Generally, the advantages of prompt decommissioning can be summarised as:

- Decreased waste disposal/handling costs.
- Decreased burden on future generations.
- Utilisation of existing technical know-how and expertise.
- Existing legislative and radiological standards are known.
- Reduced long-term care and maintenance costs.

- Increased confidence of the local community and stakeholders that the funding and expertise will be available to perform the decommissioning.

Concerns arise, however, when there is not a national nuclear waste management policy and strategy.

**7.2.1.2NORM Waste**

Australia has a number of contaminated sites resulting from past and present uranium mining activities. The extent and nature of the contamination varies from site to site. There are also a number of known deposits where no mining has taken place, but where there is some contamination resulting from exploration and from test programs in ore extraction and processing.

The wide range of climatic conditions, from tropical monsoon conditions in the far north to dry, arid conditions over much of the centre means that it is difficult to apply a uniform set of standards, or waste management and rehabilitation requirements, across the whole country.

Locations of past and present uranium mines and other deposits are shown on the accompanying Figure 1.

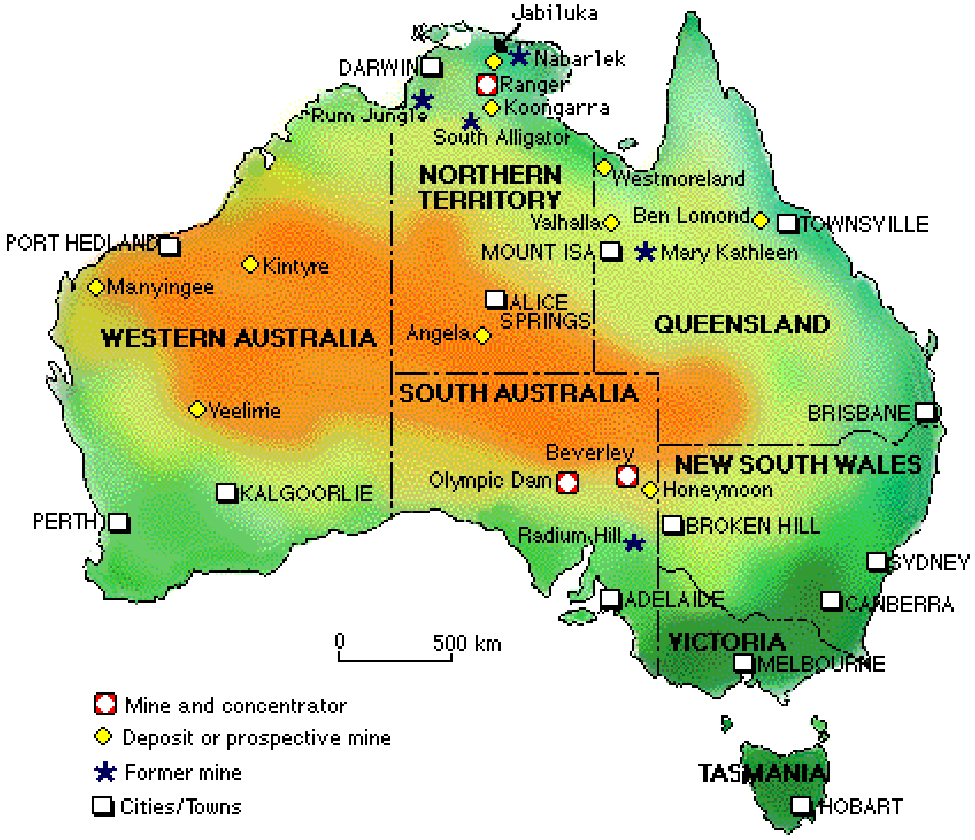



**Figure 1:** Locations of past, present and future uranium mines and deposits in Australia.

The Commonwealth developed two Codes of Practice for uranium mining: the Radiation Protection (Mining and Milling) Code 1987, and the Management of Radioactive Waste (Mining and Milling) Code 1982 (http://www.arpansa.gov.au/nuc_codes.htm). An updated and combined Code of Practice and Safety Guide "Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing 2004" will soon be promulgated. These Codes were originally developed under legislation giving the Commonwealth power to set standards for environmental protection in circumstances where Commonwealth action was required (for instance in the granting of export licences for uranium). The Codes are administered and enforced by the States.

The following guidance on cessation of operations is provided in the new Code and Safety Guide:

- The waste management plan should contain proposals for rehabilitation of the project as a whole and for individual components (for example tailings dams reaching their capacity). On decommissioning, these plans will need to be updated and engineering detail finalised.

- The regulatory authority will require assurance that the site remains in an acceptable condition until rehabilitation is complete, and that deterioration which might prejudice final rehabilitation does not occur. Inappropriate attempts at rehabilitation may prejudice the ability to attain an acceptable final state, and thus no rehabilitation operations should not be attempted without authorisation.

An application for authorisation to rehabilitate should include the following information:

- the condition of the site to be rehabilitated, including the facilities and waste to be rehabilitated, levels of contamination, and quantities of waste;
- details of rehabilitation measures to be undertaken;
- management of waste generated during rehabilitation;
- the anticipated final state of the site after rehabilitation, including estimates of the levels of residual contamination;
- details on ongoing monitoring and surveillance that will be required after rehabilitation;
- contingency plans, and plans for remediation of any defects in the rehabilitation that may become apparent.

At the conclusion of the rehabilitation, the operator may wish to relinquish responsibility for the site. Generally the requirements and conditions for this step will be set in legislation. However, requirements and responsibilities for continuing monitoring and surveillance of the site, and of any remedial work that may become necessary, will need to be determined. Any land use restrictions that may be necessary, and the administrative mechanisms that will implement them, will also need to be determined.

**7.2.1.3 Case Study on the Decommissioning of the HIFAR Reactor**

Following the permanent shutdown of the HIFAR reactor, the initial closure activities were undertaken similar to Stage 1 (defined above) under the existing HIFAR Operating Licence. These activities include removal of the fuel (completed), control arms (in progress), safety rods (in progress), rigs (in progress) and Heavy water coolant (completed).

Generally, the approach to decommissioning of research reactors has been similar and covers the three stages listed in Table 2.

| Stage 1<br>Preliminary Decommissioning | Stage 2<br>Care and Maintenance | Stage 3<br>Demolishing of the Facility and restoration of the site |
|---|---|---|
| The fuel and the fluids are drained and some ancillary structures are demolished and/or refurbished. | The facility may be maintained in this mode for a variable period of time before Stage 3 commences. Generally timeframes are;<br>• Short, within 5 years<br>• Delayed for a period of up to 30 years or<br>Perpetually with the facility maintained as a museum. | Complete removal of the facility and site is returned to a “green field”[1] state. |

The major variation between overseas decommissioning approaches has been the length of time the reactor spends in Stage 2 and, at what point and if, Stage 3 is implemented.

The decision to implement Stage 3 depends on a range of factors including:

1. The reduction in waste volume and operator dose resulting from radioactive decay
2. The availability of waste management and disposition routes
3. Economic factors, including the alignment of final decommissioning with the closure of the nuclear licensed site.

The first two considerations are obviously important for HIFAR, but the third consideration is less important as it is envisaged that ANSTO will be operating at the Lucas Heights site for at least another 40 years.

The assessment of the impact of radioactive decay, as part of the first factor, is complicated, as a full prediction of the radionuclide inventory and subsequent decay is based on the operational history of the reactor, reactor configuration and impact of experimental rigs etc. While these predictions will be necessary for formal applications to ARPANSA covering irradiated structures, for the purposes of this options study data from the then UKAEA for the DIDO reactor have been used to provide estimates of changes in inventories and doses during the decay time of the reactor. The period covered by Stages 1 and 2 allows measurements of doses, modelling of radionuclide inventories and development of detailed estimates of cost to include in a detailed Stage 3 decommissioning plan for submission to ARPANSA.

It is expected that a Commonwealth Facility for Radioactive Waste for low-level and intermediate wastes will become available around 2011. Consequently, with the development of this facility it will be possible to handle a wide range of radioactive decommissioning wastes as they are generated. When this facility becomes available, and as part of a site-wide decommissioning approach, it would be possible to consider a number of decommissioning projects, for example the decommissioning of the Moata reactor. This smaller project could provide experience for operators, retention of skills and a demonstration to the public, ARPANSA and other stakeholders that the assumptions being used to drive the options for decommissioning of HIFAR, including prediction of radionuclide inventories and doses, have been verified.

Large volumes of inactive and active waste will be generated during the dismantlement of HIFAR. Estimates of quantities are contained in Table 3 (more detailed data for each stage are contained in Table 3). It is planned that the recycling of inactive waste would be maximised.

Table 3: Estimates of Solid Waste* Generated at Each Stage of Decommissioning

| **Type of waste** | **Amount of Material (t)** | | |
|---|---|---|---|
| | **Stage 1** | **Stage 2** | **Stage 3** |
| Inactive | 196 | | 5,300 |
| Low-level Waste | 130 | limited | 460 |
| Long-lived Intermediate-level Waste | 8.4 | 0 | 492 |

* These estimates do not include incidental wastes generated by dismantling activities.

In addition to the wastes listed in Table 3, there are about 2.3 tonnes of irradiated safety rods, thimbles, coarse control arms in storage on-site in various licensed facilities.

The liquid wastes arising from Stage 1 are 10,000 L of heavy water and 5,000 L of tritium-contaminated demineralised water. Previously, it was identified that the heavy water would be treated with IX/RO to remove fission product contamination, placed in 200 L drums and returned to overseas reactors or processing facilities and the demineralised water would be stored in 200 L stainless steel drums before processing, if required, through Waste Operations.

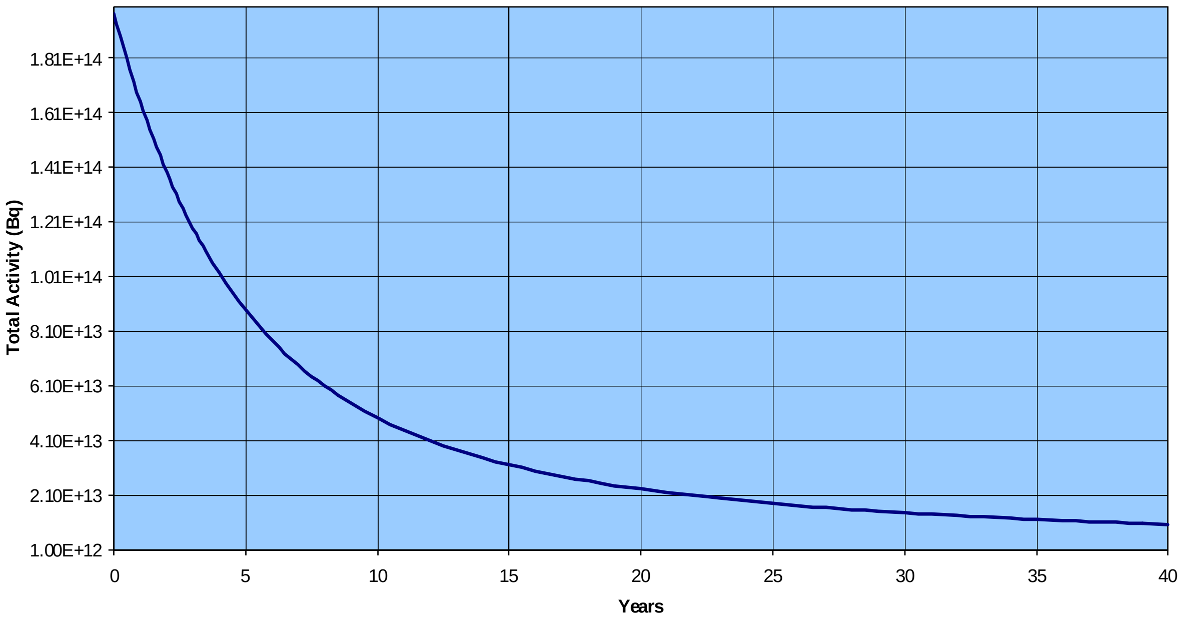
Waste arising from the decommissioning of HIFAR has been identified for disposal in the Commonwealth Radioactive Waste Management Facility. However, the availability of a suitable final radioactive waste disposal facility (Commonwealth Radioactive Waste Management Facility – CRWMF) and fulfilment of other requirements (including EIS submissions) of various relevant Statutory Bodies determined the estimated length of the waiting period under Stage 2, before the decommissioning of the facility (which will generate significant radioactive and other wastes) can be undertaken under Stage 3. For the decommissioning of the HIFAR reactor such a waiting period has been estimated as approximately 10 years, and it is expected that the CRWMF will be available by this time.

The decommissioning experience from the DIDO and PLUTO reactors in UK and the DR 3 reactor in Denmark, which are of very similar design to HIFAR, was reviewed for finalising the strategy for the eventual decommissioning of the HIFAR facility. The strategy adopted by ANSTO is in line with the programme undertaken overseas for DIDO, PLUTO as well as DR3 facilities. The major variation between overseas decommissioning approaches has been the length of time a former reactor facility spends in the storage/surveillance (i.e., in waiting mode) and at what point the actual decommissioning is undertaken.

*Radionuclide Inventories and Dose Estimates*

Data for the radionuclide inventory and resulting doses from the calculations for the DIDO reactor by the then UKAEA are shown in Figure 2. (This data for the level of radioactivity are considered to be conservative, as DIDO operated at ~ 700 MW-years while HIFAR has operated at ~ 460 MW-years). The estimated radionuclide inventory drops by a factor of about 7 over the first 10 years after de-fuelling, and by about a factor of 10 over the first 20 years after de-fuelling. Thereafter, there is very little drop off in activity. Consequently, there may be little advantage from a dose reduction perspective in delaying decommissioning for more than 10 years after de-fuelling the reactor. This is particularly the case given that it is expected that remote handling equipment and shielding would be used in decommissioning whenever it was carried out to reduce the doses to operators to as low as reasonably achievable levels.

**Figure 2:** Radioactive Decay of DIDO Activity Inventory in Structural Materials over 40 years
(Isotopes included: $^{3}H$, $^{14}C$, $^{55}Fe$, $^{60}Co$, $^{63}Ni$, $^{65}Zn$, $^{113m}Cd$, $^{133}Ba$, $^{152}Eu$ & $^{154}Eu$)




In May 2007 ANSTO submitted an application to the federal regulator ARPANSA for a licence to commence the second decommissioning stage for the HIFAR reactor. The new licence will allow ANSTO to dismantle non-radioactive parts of the facility allow a 10 year decay period and then begin the detailed planning needed for the final decommissioning around 2016. ANSTO's activities are independently over-sighted by the regulator ARPANSA which issues licences for each stage of the lifetime of nuclear facilities.

Under this licence, four key activities will take place: the preliminary dismantling of non-radioactive systems that are not required such as cooling towers; refurbishment of systems needed to ensure completion of the process; gathering samples to support the inventory of radioactive material; and ongoing maintenance and surveillance. All the activities to be undertaken under this new licence will be managed in accordance with ANSTO's safety management systems, which were responsible for the reactor's excellent safety record of almost 50 years of operation.

Another licence and an approval under the Commonwealth Environment Protection and Biodiversity Conservation Act will be required before the final decommissioning phase can commence. Prior to HIFAR being finally shutdown a community discussion was held in the local area to brief residents about the processes involved in decommissioning of the nuclear reactor.

Figures 3 to 13 show Stage 1 Preliminary Decommissioning of HIFAR. The fuel and the fluids are drained and some ancillary structures are demolished and/or refurbished.

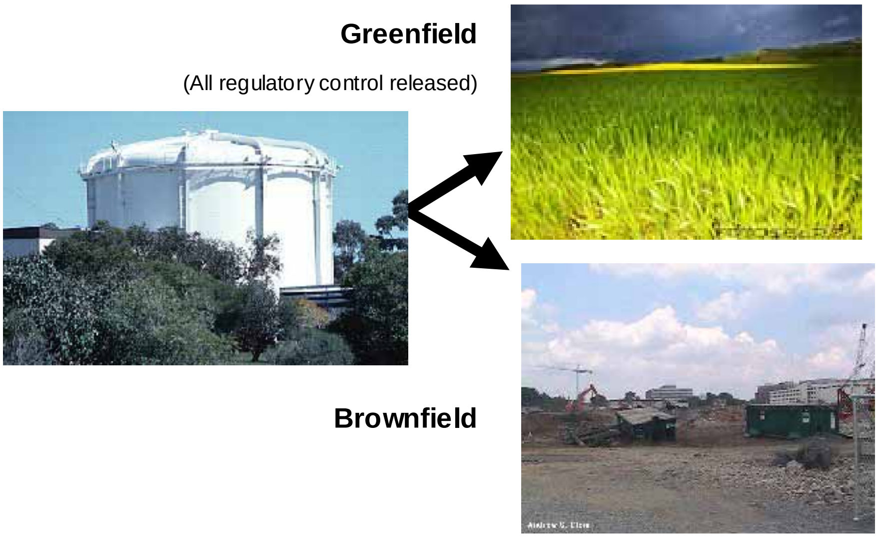
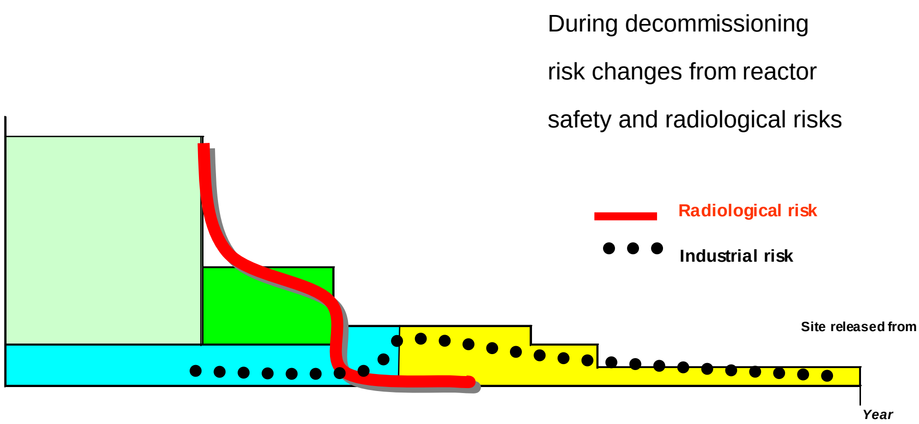



Figure 3: HIFAR Decommissioning




Source: IAEA DeSa Meeting, November 2006

Figure 4: Risks During Decommissioning

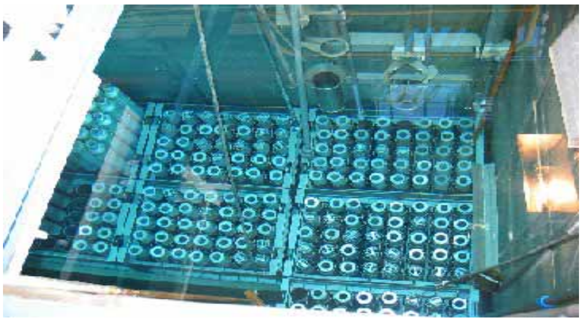


**Fig 5:** Spent Fuel removed from HIFAR storage awaiting shipment to US

**Fig 6**: Heavy Water from HIFAR

**Fig 7:** Non radioactive experimental equipment to be removed

**Fig 8:** Secondary water cooling system pumps to be demolished

**Fig 9:** Secondary cooling system towers

**Fig 10:** Secondary cooling system pond

**Fig 11:** Electrical supply station

**7.2.1.4 Case Study on Waste Clearance at ANSTO**

The waste certification and release control system at ANSTO takes a 'defence in depth' approach to control the release of radioactivity. As discussed below, waste generated from non-controlled areas is assessed at least once for radioactivity, before being released for disposal. Waste arising from controlled areas is subjected to a three-stage assessment process, using radiological characterisation techniques and process knowledge, before release from the site. When assessing wastes previously classified as radioactive waste which have since decayed to clearance levels, a four-stage assessment system is employed to ensure the waste released is safe and suitable for unrestricted disposal. A simplified flow chart of waste movements through these stages is given in Figure 14.

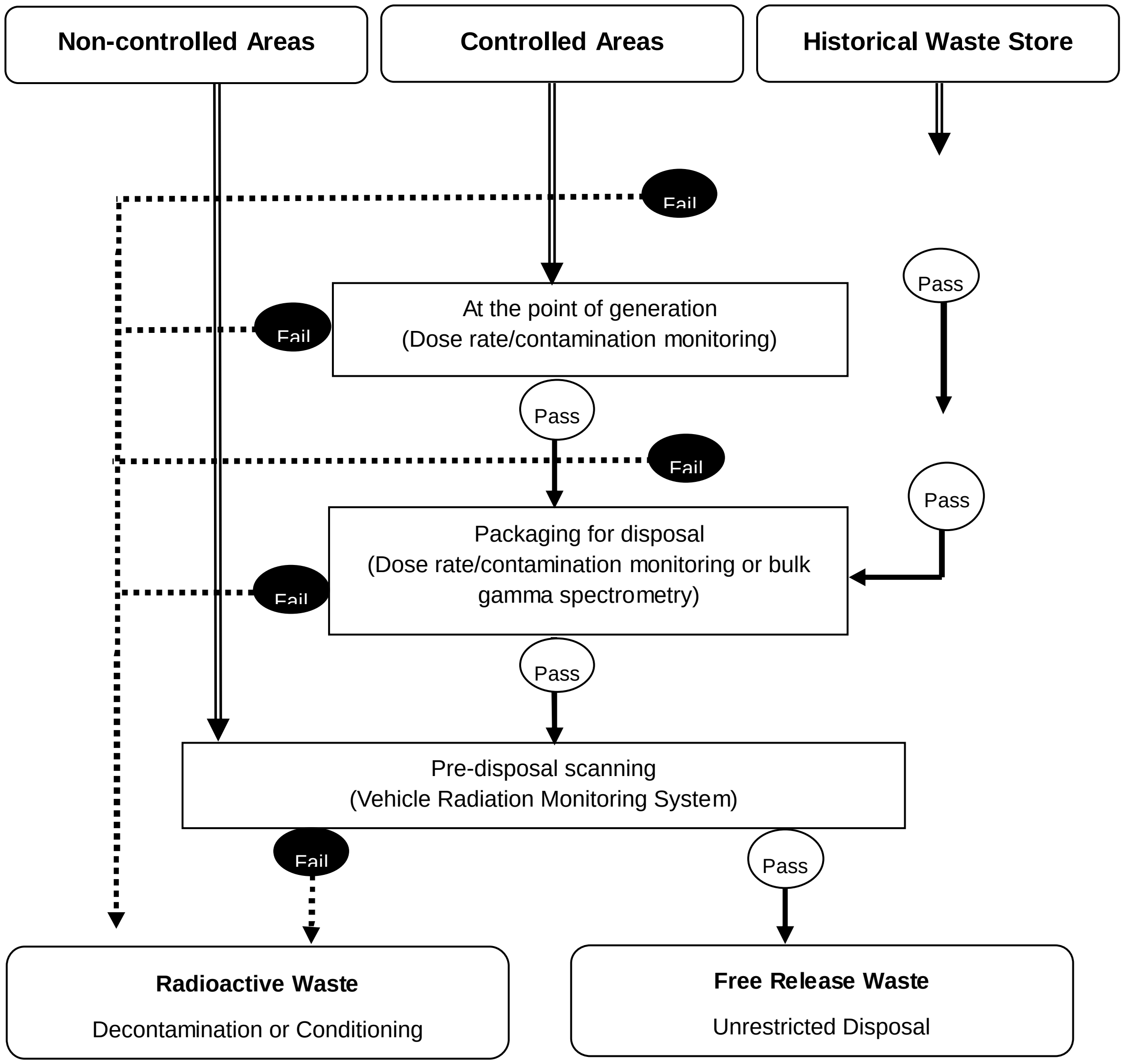



Figure 14: Assessment of Wastes at ANSTO

Some of ANSTO's historical radioactive waste inventory includes waste suitable for free release, incorrectly identified as radioactive waste in the past. This is partly attributable to the previous waste classification practices, which were based on gross beta/gamma count rate measurements rather than nuclide-specific waste characterisation. Further, some waste classified as radioactive waste in the past contained short-lived radionuclides which have since decayed in storage to levels suitable for free release. Such waste is processed through a four-stage assessment and classification process, using radiological characterisation techniques and process knowledge, similar to the assessment process used for ongoing waste arisings.

Table 4 shows examples of waste released based on radionuclide specific activity concentration measurements. The implementation of the clearance limits specified in RS-G-1.7 has relaxed the limits for release of waste with naturally occurring radioactivity.

Prior to the introduction of RS-G-1.7 limits, the BSS recommendations in conjunction with IAEA TECDOC 1000 [7] recommendations (10% BSS limits for release of bulk material) led to a very conservative activity concentration limit for naturally occurring activity in waste. With the introduction of RS-G-1.7 limits, these limits have now been raised to 14 Bq/g and 11 Bq/g for U-nat and Th-nat respectively.

**Table 4:** Some Examples of Waste Released for Unrestricted Disposal

| ***Description of waste*** | ***Origin*** | ***Activity concentration (Bq/g)*** | | ***Weight (tonne)*** |
|---|---|---|---|---|
| Decayed Activated carbon from filters used in radioisotope production facilities. | Waste was cleared from the LLSW Store after decaying in storage. | K-40 | 0.099 | 3.6 |
| | | Co-60 | 0.001 | |
| | | Sr-90 | 0.003 | |
| | | Sb-125 | 0.006 | |
| | | Cs-137 | 0.003 | |
| | | Th-nat[a] | 0.006 | |
| | | U-nat[b] | 0.029 | |
| Soft waste (Gloves, cloth, swabs, paper towels, etc.) | Waste from laboratory and radioisotope production facilities. | K-40 | 0.036 | 0.4 |
| | | Co-60 | 0.005 | |
| | | Zn-69m | 0.006 | |
| | | Sr-90 | 0.040 | |
| | | Zr-95 | 0.042 | |
| | | Nb-95 | 0.070 | |
| | | Ru-103 | 0.432 | |
| | | Ru-106 | 0.141 | |
| | | Te-123m | 0.002 | |
| | | Sb-125 | 0.017 | |
| | | Cs-137 | 0.040 | |
| | | Ce-141 | 0.026 | |
| | | Ce-144 | 0.123 | |
| | | U-nat[b] | 0.002 | |
| Topsoil | Excavation spoil from site excavation work. | K-40 | 0.129 | 4.5 |
| | | Th-nat[a] | 0.264 | |
| | | U-nat[b] | 0.052 | |
| Mineral ore samples | Waste from the minerals processing pilot plant. | Ra-223 | 0.003 | 2.3 |
| | | Fr-223 | 0.003 | |
| | | Th-nat[a] | 0.151 | |
| | | U-235[c] | 0.003 | |
| | | U-nat[b] | 0.091 | |
| Grit blast | Lead contaminated grit blast used in the removal of lead paint from effluent mixing tanks. | K-40 | 0.060 | 32.4 |
| | | Co-60 | 0.002 | |
| | | Sr-90 | 0.004 | |
| | | Cs-137 | 0.004 | |
| | | Th-nat[a] | 0.036 | |
| | | U-nat[b] | 0.025 | |

a. The presence of all members of thorium series in the same activity level is assumed.

b. The presence of all members of uranium series in the same activity level is assumed.

c. The presence of all members of actinium series in the same activity level is assumed.

Since late 2003, a significant amount of waste has been released as *free release waste* through the exemption and clearance processes. Most of these drums were assessed and released prior to the adoption of RS-G-1.7 limits in January 2005. The concentration of radionuclides in waste released after January 2005 has met RS-G-1.7 limits. Notwithstanding this variance, the radioactivity of all drums released to date are well below the exemption limits specified in the *Australian Radiation Protection and Nuclear Safety Regulations 1999* and the *Radiation Control Regulation 2003 (NSW)*.

Waste released to date includes waste held in the LLSW Store such as decayed activated carbon, originally classified as radioactive waste due to the presence of I-131, and sand residue extracted from stormwater collection pits, incorrectly classified as radioactive waste due to the presence of trace levels of Cs-137 and Sr-90. The vast majority of the waste released to date shows little or no activity from radionuclides other than naturally occurring levels of K-40, Th-nat and U-nat.

Figures 15 to 17 show processing of exempt level for disposal.

**Fig: 16:** Exempt Level Waste removed from drums for clearance and disposal

**Fig: 17:** Cleared waste scanned for contamination

## 7.3 Problems to be Resolved

There are a number of current issues that will require further assessment and discussion. These include:

### *Decommissioning*

Australia has no radioactive waste disposal facility for low or intermediate and as such the decommissioning of its two research nuclear reactors will continue to be an issue in terms of final decommissioning and release of the sites for unrestricted use. Interim radioactive waste storage facilities will need to considered approved and licensed by the regulator if a final decommissioning route is chosen.

### *Waste Clearance*

A significant amount of glass bottles with trefoils (label stickers) has been accumulated from decayed historical waste which also contains sharps. This waste cannot be disposed of in municipal landfills

Solution: Incineration but would need considerable assessment by the regulator and public acceptance to incinerate radioactive waste in Australia.

Release limits of Cs-137 and Co-60 is highly restrictive at 0.1 Bq/g limit for each nuclide. This limit is difficult to justify on scientific grounds:

- Dose per unit intake ~ 1X10-8 Sv/Bq, i.e. need to ingest 1000 Bq of radionuclides to get a dose of 10 mSv.
- CODEX allows up to 1000 Bq/kg in food, affected by an accidental release of radioactivity.

Options for relaxing limits based on:

- Restricted disposal
- Reassessment of applicable exposure scenarios at local facilities

### *NORM Waste*

In the nuclear power industry, stringent design and operational controls are applied to reduce radiation exposures and the probability of accidens. In most NORM industries the potential for this type of serious accident does not exist, hence any proposed precautions in most NORM industries may need to be based only on control of radiation exposures.

Despite the widespread occurrence of NORM, and withstanding the development of guidance material in some countries and by international authorities, there is no systematic international approach to regulating NORM in commodities and products, and for the management of NORM wastes.

Similarly in Australia, there is no uniform approach to NORM issues. Developing Australia's requirements for regulatory controls over NORM in isolation from the international community could lead to trade difficulties for Australian mineral producers and processors. As such ARPANSA is currently assessing and seeking feedback from interested paries on NORM issues in Australia, in particular on whether there is a need to:

- Develop national guidance on exclusion, exemption and clearance for natural radioactive material, to enable a uniform approach to establishing criteria that may be used to regulate NORM in all jurisdictions. The guidance would take the existence and variability of the natural background into consideration, and also allow for the wide range of scenarios that can lead to exposure to ionising radiation from materials containing NORM.
- Develop national guidance on strategies and criteria for the treatment and disposal of NORM arising from various process streams, including landfill and spreading.
- Develop guidance for remedial actions at sites contaminated historically by NORM waste generation.
- Develop a strategy for raising awareness of NORM issues, both in relevant industries and the public generally.

## 7.4 Conclusion

Australia does not have a nuclear power program but has safely operated nuclear research reactors for the past 50 years. The Australian Nuclear Science and Technology Organisation (ANSTO) operate the only nuclear research reactor in Australia. Currently there are 2 research reactors that have been shut down at ANSTO and are in various stages of decommissioning. Immediate dismantling of the research reactors is not an option as Australia does not have an operating radioactive waste disposal facility. ANSTO's decommissioning plans are to fully dismantle the smaller 100 kW Moata reactor within the next 3-4 years. Radioactive waste volumes from the Moata reactor decommissioning will be minimal and will be processed, packaged and stored at ANSTO awaiting final disposition.

The 10mW HIFAR reactor (shut down in January 2007) has completed Stage 1 decommissioning and a licence application has been submitted to the regulator (ARPANSA) for the reactor to be placed under a period of care and maintenance (Stage 2) or a "Possess and Control" Licence phase for up to 10 years. The 10 year "Possess and Control" period will allow time for decay of the radioactive inventory and at the same time allow a decision to be made in the establishment of the proposed Commonwealth Radioactive Waste Management Facility planned for the Northern Territory.

Waste clearance and disposal will also be an integral part of radioactive waste management during the decommissioning of the ANSTO research reactors. As such ANSTO has implemented a waste release control system that takes a ‘defence in depth’ approach to control the release of radioactivity. Waste arising from controlled areas is subjected to a three-stage assessment process, using radiological characterisation techniques and process knowledge, before release from the site.