ISSUES PAPER FOUR

MANAGEMENT, STORAGE AND DISPOSAL OF NUCLEAR AND RADIOACTIVE WASTE

NUCLEAR FUEL CYCLE ROYAL COMMISSION

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MANAGEMENT, STORAGE AND DISPOSAL OF NUCLEAR AND RADIOACTIVE WASTE

THE NUCLEAR FUEL CYCLE ROYAL COMMISSION IS TASKED BY ITS TERMS OF REFERENCE WITH CONSIDERING THE FEASIBILITY OF ESTABLISHING FACILITIES IN SOUTH AUSTRALIA FOR THE MANAGEMENT, STORAGE AND DISPOSAL OF NUCLEAR AND RADIOACTIVE WASTE FROM THE USE OF NUCLEAR AND RADIOACTIVE MATERIALS IN POWER GENERATION, INDUSTRY, RESEARCH AND MEDICINE (BUT NOT FOR MILITARY USES), THE CIRCUMSTANCES NECESSARY FOR THOSE FACILITIES TO BE ESTABLISHED AND TO BE VIABLE, THE RISKS AND OPPORTUNITIES ASSOCIATED WITH ESTABLISHING AND OPERATING THOSE FACILITIES, AND THE MEASURES THAT MIGHT BE REQUIRED TO FACILITATE AND REGULATE THEIR ESTABLISHMENT AND OPERATION.

YOUR SUBMISSION

The Royal Commission is seeking submissions from interested members of the community, both within Australia and overseas, who have evidence, information or views which are relevant to its inquiry.

The purpose of this Issues Paper is to assist those proposing to make a submission to the Royal Commission.

It provides a factual background, from identified sources, relevant to understanding the questions on which the Commission seeks submissions. A submission should be in response to the questions posed in this Issues Paper. Your submission may address all, some or only one of the questions. Your submission is not limited by the factual background set out in this Issues Paper.

If you wish to make a submission on a topic that is not in response to a question in this Issues Paper you may do so, but it must be contained as an Appendix to your main submission which addresses the questions posed.

Before writing your submission you should read the Submissions Guideline (www.nuclearrc.sa.gov.au) issued by the Royal Commission. It may answer questions you have as to the form and content of your submission and how your submission will best assist the Commission.

A. NUCLEAR AND RADIOACTIVE WASTE

Radioactivity is a property of an element (such as uranium) to emit radiation. Radiation is emitted when an element spontaneously transforms into another element.

Some wastes have this characteristic because they are comprised of, or contaminated with, radioactive substances. Nuclear waste is comprised of an element, or elements, that are themselves radioactive. Examples include elements produced in spent fuel following its use in a nuclear power plant. Radioactive wastes are materials contaminated with substances that are radioactive, such as discarded equipment used in nuclear medicine.

During uranium mining and further processing, the radioactivity of the waste originates from naturally occurring elements in the original ore body, the most significant of which are uranium and radon. During nuclear reactor operation, other radioactive elements are created. These elements are created as a result of the breaking apart of uranium (fission). The sources of waste at each stage in the fuel cycle are addressed in other Issues Papers.

The most significant considerations which affect the management, storage, and disposal of these wastes are the longevity of the elements that produce the radiation (the half-life), the energy of the radiation (which affects its ability to penetrate and travel through materials) and the amount of radiation. For those reasons, nuclear and radioactive wastes have been divided into internationally agreed categories by the International Atomic Energy Agency (IAEA). The six categories are:

- Exempt Waste (EW): Waste in this category is excluded from regulatory controls as radioactivity concentrations are at or below exclusion levels.
- Very Short-Lived Waste (VSLW): VSLW contains radioactive elements with half-lives of less than 100 days and, depending on clearance by regulatory bodies, is stored temporarily on the site from which it originated. Generally, VSLW is produced by research and medical activities.
- Very Low Level Waste (VLLW): VLLW has limited concentrations of radioactivity greater than that which is generated by VSLW, but not to such an extent that disposal as radioactive waste is warranted. Waste in this category may include soil, concrete, rubble and ashes.
- Low Level Waste (LLW): LLW requires only containment and no shielding during storage or transportation. The LLW currently being generated in Australia consists largely of paper, plastics and scrap metal items which have been used in hospitals and research institutions including the OPAL research-reactor. LLW requires isolation and containment for a few hundred years.
- Intermediate Level Waste (ILW): Examples of ILW include used reactor core components, fuel elements that have undergone reprocessing and resins and filters used to keep reactor water systems clean.
- High Level Waste (HLW): Waste with levels of activity concentration high enough to generate significant quantities of heat by the radioactive decay process or waste with large amounts of long lived radioactive elements. HLW typically comprises spent nuclear fuel, if it is intended for final disposal, or wastes from reprocessing of spent fuel. The generally recognised option for disposal of HLW is disposal in deep, stable geological formations usually several hundred meters or more below the surface.

The level of radioactivity in each of these waste categories and the rate at which they decay is depicted in Figure 1.[1]

The categorisation of the waste based on its activity and longevity is relevant to the techniques applied in its management, storage and disposal.

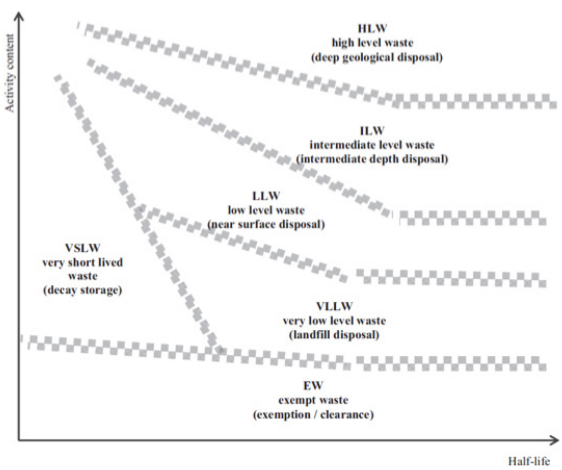


Figure 1: Illustration of the IAEA classification system for radioactive waste

[1] International Atomic Energy Agency (IAEA) Safety Standards Classification of Radioactive Waste General Safety Guide No. GSG-1, November 2009, available at http://www-pub.iaea.org/MTCD/publications/PDF/Pub1419_web.pdf.

B. FACILITIES AND TECHNIQUES FOR THE MANAGEMENT, STORAGE AND DISPOSAL OF WASTE

Due to their characteristics, nuclear and radioactive wastes require management from the point of their production to their final disposal. Management refers to the entire approach to handling, transporting, storing and final disposal of that waste stream. Waste storage refers to that part of the process concerning either temporary or permanent control of the waste (in secure and managed facilities) in a manner that allows access for transportation or reprocessing. Disposal is an ultimate process, where the wastes are intended to be addressed in a permanent and irrecoverable manner. Some disposal techniques still envisage the waste being retrievable.

Typically, low level waste is stored securely on the premises where it is produced. It is not required to be stored in purpose-built facilities, but the circumstances of its storage must be managed. It is commonly stored in designated spaces in hospitals, universities, research institutions or government centralised facilities.

Because intermediate level waste has a higher level of radioactivity, it is typically stabilised before storage. One technique of stabilisation involves its fixation within a concrete matrix. Other methods of fixation include vitrification and SYNroc. Vitrification involves the melting, mixing and cooling of radioactive and nuclear wastes with sand to form a glass. SYNroc, or "synthetic rock", is an advanced ceramic composed of stable titanate minerals that immobilises radioactive and nuclear wastes through hot isostatic pressing (HIP). Vitrification has been used for storage and containment of both intermediate and high level waste in Australia. SYNroc has been used for intermediate level waste and is proposed to be used in the near future for high level waste.[2] New techniques are also under development in Russia, Sweden and Finland.[3] These methods include polymerisation which is a process of incorporating waste into a plastic or resin.

Once stabilised, intermediate level waste is then packaged securely in steel drums at the place where it was produced and stored in purpose-built facilities comprised of concrete and steel chambers. Such facilities might be either above or below ground, but their design must take into account issues of radiation protection outside the facility and the nature of the nuclear material to be stored, including its volume, heat-dissipation requirements and the half-life of all relevant isotopes. One mitigation measure for intermediate level waste is to reprocess it to extract the high emission elements for reuse in the nuclear fuel cycle.

Typically, infrastructure required on-site at a purpose-built waste disposal facility would include buildings for the conditioning of the waste, storage structures, a laboratory for quality assurance and administrative offices.

High level waste requires much more sophisticated management and storage techniques. Because of its heat generating properties, the common practice is to first store it temporarily on site where it is generated. It initially undergoes "wet casking" which is designed to address an intense initial period of radioactivity. In this process, the waste is stored in purpose-designed casks in underwater ponds. Subsequently, the waste can be transferred to "dry casking", which involves the waste material being placed into steel-lined concrete silos on site and subsequently prepared for transport. Stabilisation occurs at this stage. Both of these storage options are temporary. Much accumulated high level waste generated by nuclear plants remains stored in this way.

The current approaches to final disposal involve either near-surface for intermediate level waste or deep geological options for high level waste. Near-surface storage involves burial in geologically selected and specially engineered cavities to a maximum depth of 50 metres. These methods are currently being developed in Finland and Sweden.

Deep geological storage involves the establishment of facilities for the placement of vessels containing waste beneath the Earth's surface at depths of up to 5000m. The waste would be loaded into either steel or copper vessels, following encasement in a non-corrosive, inert substance (usually a clay). The construction of these facilities would involve engineered shafts or bores with storage chambers. Options include mine repositories (with a depth of 200 to 1000 m) or deep boreholes (at least 5000 m deep) which are lined with clay or salt. Posiva Oy commenced the process to establish a deep geologic facility at Olkiluoto in Finland in the last decade and is due to first receive waste in 2020.

Presently, research into the current engineering of nuclear and radioactive waste storage facility designs is ongoing, especially in relation to potential future impacts and predicted lifetimes of facilities. This research has involved the use of computer modelling simulations and experimental scientific studies both in Australia and overseas.

FACILITIES AND TECHNIQUES FOR THE MANAGEMENT, STORAGE AND DISPOSAL OF WASTE CONTINUED

Many factors affect the suitability of locations for the storage and disposal of nuclear and radioactive wastes. Relevant considerations include tectonic activity, rock type, depth of geological formation, capacity for heat transfer or retention, interaction with ground and surface water, the mineral potential of an area (as storage may inhibit mineral or petroleum extraction) and interaction with current or future local activities. The significance of each of these matters depends on the type of facility being considered and the nature of the waste to be stored. However, information about all of these matters must be considered so that locations can be identified and appropriately engineered structures can be designed, built and maintained.

As to tectonics and geology, two-thirds of South Australia is underlain by the solid nucleus of the Gawler Craton (Figure 2) which dates back to 3.3 billion years and is generally overlain by deep sedimentary cover. The State does experience infrequent earthquake activity in a zone of geological faults. Those faults match historic earthquake epicentres and the majority are located along the Mount Lofty, Musgrave and Flinders Ranges and the eastern Eyre Peninsula (Figure 2).

Figure 2: Active geological fault zones of South Australia and Great Artesian Basin (after DSD SARIG 2015)

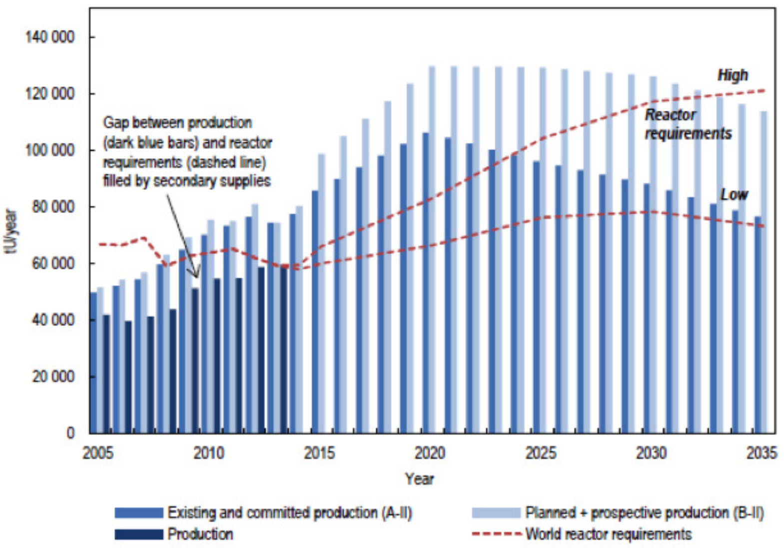
With these issues in mind,

4.1. Are the physical conditions in South Australia, including its geology, suitable for the establishment and operation of facilities to store or dispose of intermediate or high level waste either temporarily or permanently? What are the relevant conditions? What is the evidence that suggests those conditions are suitable or not? What requires further investigation now and in the future?

In addressing question 4.1, the Commission is tasked with considering the feasibility of establishing and operating a facility in South Australia. It is not, however, tasked with making a finding about the suitability of a specific site (or sites) within South Australia for a possible facility to store or dispose of waste. Rather, it will address the issue of site selection in a more general sense by identifying the factors relevant to that decision and best practice in that process (see, in particular, question 4.5).

The primary source from which nuclear and radioactive wastes are produced is electricity generation. Internationally, 210,000 m^3 of nuclear and radioactive wastes are produced annually. 95% of that amount is low and intermediate level waste.[4]

Worldwide, reactor ponds currently store 90% of the accumulated 270,000 t of spent fuel in managed storage, with the remainder in dry storage.[5] From the 12,000 t of spent nuclear fuel being produced per year, 25% is currently sent for reprocessing. Even with increases in the efficiency of fuel consumption in nuclear reactors, it is projected by the OECD that there will be an increase in the consumption of nuclear fuels and therefore a corresponding, but not equal, increase in the production of nuclear and radioactive wastes. However, as can be seen in Figure 3, the 'High' and 'Low' cases include a relatively wide range of possible scenarios for future requirements for nuclear fuel and thus production of waste.



Source: Tables 1.26 and 2.4.

* Includes all existing, committed, planned and prospective production centres supported by RAR and inferred resources recoverable at a cost of <USD 130/kgU.

Figure 3: Projected world uranium production to 2035 with world reactor requirements.[6]

Radioactive and nuclear-waste storage is managed by private and government entities in many different countries, including the United States of America, the United Kingdom, France and Finland. The costs of the facilities and future storage are typically funded through a collection of electricity generation levies, but also through budget expenditures. For example, in the United States of America, electricity customers have contributed US$28 billion to their nuclear and radioactive waste fund. These funds have been estimated to represent 5% of the costs of electricity generation.

Separate to the establishment of interim and long term repositories by governments in many countries which operate nuclear plants, the IAEA has discussed the establishment of an international collective radioactive waste repository. Such a system would potentially house radioactive and nuclear wastes from a variety of countries.

The Commonwealth Government states that over the last 40 years, 4,906 m^3 of radioactive waste has accumulated in Australia. That is comprised of 4,250 m^3 of low level and 656 m^3 of intermediate level wastes.[8] Currently, Australia produces up to 81 m^3 of radioactive waste per year, comprised of 40 to 70 m^3 of low level waste and 5 to 11 m^3 of intermediate level waste. This waste is generated by the manufacture of radioisotopes in medicine, research and industry, with research-reactor waste undergoing reprocessing overseas before its return to Australia.[9]

In Australia, radioactive and nuclear waste is managed and stored by the Commonwealth and State governments and other institutions and organisations. This waste is managed and stored in a number of centralised and decentralised facilities, including secure stores, either above ground or near surface. Low level waste and intermediate level waste is stored in suitably engineered and monitored facilities located as close as possible to the site at which the waste was produced. The South Australian Environmental Protection Agency (EPA) identified in an audit conducted in 2003 that there are 80 radioactive waste sites located in South Australia with a total of 8 m^3 of low and intermediate level waste.[10] There is also 2, 010 m^3 of low level waste being managed by the Commonwealth Government in Woomera.[11] There are low level repositories located in all other States and Territories.[12]

Presently, the Commonwealth Government is seeking to identify a site on which it can co-locate both low and intermediate level wastes in a proposed National Radioactive Waste Repository.[13]

FACILITIES AND TECHNIQUES FOR THE MANAGEMENT, STORAGE AND DISPOSAL OF WASTE CONTINUED

Australia has not accepted waste originating from overseas nuclear activities and does not produce any high level waste.[14] As part of the Australian Nuclear Science and Technology Organisation's (ANSTO) spent fuel storage program, spent fuel from Australian research reactors are due to be returned to Australia by 2015 from facilities overseas. That waste has been reprocessed in the United Kingdom, United States and France and is intended to be stored in an interim storage facility to be constructed at ANSTO.

In the specific case of waste arising from the operations of a nuclear reactor, where Commonwealth entities are concerned, the Commonwealth Government through the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) regulates by licencing the construction or operation of nuclear waste storage or disposal facilities. ARPANSA also publishes codes and standards which provide guidance as to best practice in radioactive waste storage and disposal to minimise risks to people or the environment. Separately, there is a prohibition against the construction or operation of facilities for the storage or disposal of nuclear wate in South Australia and its transport into and within the State, under the *Nuclear Waste Storage Facility (Prohibition) Act 2000* (SA).

The facilities in South Australia at which low and intermediate level radioactive waste is stored are regulated under the *Radiation Protection and Control Act 1982* (SA).

Against that background,

4.2. Are there nuclear or radioactive wastes produced in Australia which could be stored at a facility in South Australia? In what circumstances would the holders of those wastes seek to store or dispose of that waste at facilities in South Australia?

4.3. Would the holders of nuclear or radioactive waste outside Australia seek to store or dispose of that waste in South Australia? Who holds that waste? What evidence is there that they are seeking options to store or dispose of wastes elsewhere including in locations like South Australia? If so, what kinds of waste and what volumes might be expected? What would the holders be willing to pay and under what arrangements?

4.4. What sorts of mechanisms would need to be established to fund the costs associated with the future storage or disposal of either Australian or international nuclear or radioactive wastes? Are there relevant models in operation which should be considered? What mechanisms need to be put in place to increase the likelihood that the South Australian community, and relevant parts of it, derive a benefit from that activity?

[2] E.R. Vance, *Journal of the Australia Ceramics Society*, vol. 50(1), 2014, pp. 38 – 48.

[3] WNA, February 2015, *Radioactive Waste Management* Appendix 2, available at http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Nuclear-Wastes/Appendices/Radioactive-Waste-Management-Appendix-2--Storage-and-Disposal-Options/.

[4] WNA, March 2015, *Radioactive Waste Management*, available at http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Nuclear-Wastes/Radioactive-Waste-Management/.

[5] As above.

[6] Uranium 2014 report, OECD.

[7] WNA, March 2015, *Radioactive Waste Management*, available at http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Nuclear-Wastes/Radioactive-Waste-Management/.

[8] Commonwealth Department of Industry and Science, Australia's Radioactive Waste, available at http://www.radioactivewaste.gov.au/radioactive-waste-australia/australias-radioactive-waste.

[9] WNA, March 2015, Radioactive waste repository & store for Australia, available at http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Appendices/Radioactive-waste-repository---store-for-Australia/.

[10] SA EPA, Audit of Radioactive Material in South Australia, September 2003.

[11] URS, Radioactive Waste Store Feasibility Study – Stage Three, 3 November 2005.

[12] ANSTO, January 2011, Management of Radioactive Waste in Australia, available at http://www.ansto.gov.au/__data/assets/pdf_file/0020/46172/Management_of_Radioactive_Waste_in_Australia_v2.pdf.

[13] Commonwealth Department of Industry and Science, available at http://www.radioactivewaste.gov.au .

[14] ANSTO, Managing waste at ANSTO, available at http://www.ansto.gov.au/NuclearFacts/Managingwaste/ManagingwasteatANSTO/index.htm.

C. RISKS AND OPPORTUNITIES

Nuclear and radioactive wastes present risks to the community and the environment that need to be managed in order to protect health and safety. The risks arise principally from radiation – whether directly from the waste or indirectly through potential contamination of the environment and further exposure to humans and other biological organisms from those sources. Though humans and other biological organisms are exposed throughout their lives to radiation from natural sources (such as cosmic radiation, the Earth and the environment) exposure to radiation from nuclear and radioactive wastes presents more substantial risks.

The extent of those risks depends upon the radioactive substances, types of radiation emitted, their extent and their physical and chemical forms.[15] The greater risks for humans and the environment are presented by intermediate and high level wastes. Accordingly, purpose-built facilities for their management must address those greater risks.

Those risks need to be analysed comprehensively, bearing in mind the facilities in which those wastes would be stored and the sorts of precautions that would ordinarily be required, as well as transporting wastes to those facilities.

Facilities for the storage of intermediate level and high level waste are ordinarily located away from population centres and are sited following a considered planning process.[16] Site selection for a storage or disposal facility would consider the type of facility and waste being stored (including its longevity), geological stability, generation of heat, geographical matters as well as operational issues such as amenity. Siting and operation must also take potential environmental impacts into account. In addition to the management of radiative exposure, a significant issue is the potential for the contamination of groundwater sources. Addressing that issue requires an understanding of the current frequency, flow and volume of surface and ground waters. Management of water resources from sourcing and storage will be required if such a facility were to be sited in South Australia. Also significant is the potential risk of land contamination at handling, storage and disposal sites. Aside from its ecological impact upon animals and plants, contamination of the environment has implications for the health and safety of humans who use those resources.

As part of planning and siting, buffer zones are established to minimise health and safety risks to the community. The extent of community buffer zones depends on an analysis of potential exposure in accordance with international standards developed by the IAEA. For example, buffer zones are established around the Lucas Heights Reactor in Sydney, New South Wales. The buffer zone at this facility is currently 1.6 km between the reactor and members of the community.

The process for selecting a site would also require consultation and negotiation with landholders and holders of native title rights. It would also need to take account of any sites of aboriginal significance that are protected under the *Aboriginal Heritage Act 1988* (SA).

Regulations are in force to ensure the safety of people who work with radioactive waste and the community generally by specifying maximum levels of safe exposure to radiation. Pursuant to the *Radiation Protection and Control Act 1982* (SA) and its Regulations, the exposure of workers to radioactive waste within facilities is managed through a range of techniques. The exposure of persons to radiation is to be kept below maximum limits and "as low as reasonably achievable" in the relevant circumstances. Occupational radiation exposure is limited by segregating storage and working areas. Radiation sources within these facilities are also stored in appropriate transport or shipping containers to ensure worker safety. Depending on the level of activity of the radiation source, working within these areas is controlled by restrictions such as time limitations. Exposure is also monitored by the use of external dosimeters (including personal tagging and scintillometers). The general public is excluded from entering facilities where radioactive waste is stored to prevent exposure. Guidelines and requirements for the community's protection from radiation exposure are developed in accordance with Australian and international standards.

The *Radiation Protection and Control Act 1982* (SA) requires that people and organisations hanndling radioactive waste need to be licenced. Prior to owning a radiation source, an owner must, depending on the nature of the source, obtain the relevant licence which authorises possession of that source. In applying for a licence, applicants must ensure that they have a Radiation Management Plan. For those companies that use and dispose of unsealed radioactive waste often (such as hospitals), an approved Radioactive Waste Management Plan is required which details the method of disposal. It is the responsibility of licensed owners to ensure that radioactive waste is appropriately packaged for transport and that a contingency plan is in place should any incident occur during its carriage.

RISKS & OPPORTUNITIES CONTINUED

At the national level, regulation of radioactive waste is carried out in conformity with Australia's international obligations under IAEA standards and, in relation to spent fuel, in accordance with the Treaty on the Non-Proliferation of Nuclear Weapons. Depending on the nature of the radioactive waste, both Commonwealth and State agencies regulate the possession and management of it by issuing licences which impose conditions as to its handling. Specific permission is required prior to any importation of radioactive waste into Australia pursuant to the *Customs (Prohibited Imports) Regulations 1956* (Cth) and that permission must be obtained before ARPANSA will issue a licence authorising its possession.

The transportation of waste, particularly from other countries, to a possible facility in South Australia would require careful consideration to be given to the means of handling and security of that waste. Transportation of radioactive wastes in Australia must comply with the principles established in the Code of Practice for the Safe Transport of Radioactive Material which adopts international standards for transport.[17]

In the absence of any prohibition, the establishment of facilities for the storage or disposal of waste generated by nuclear activities would, in addition to health and safety regulations, already be subject to both State planning and environmental protection legislation and Commonwealth environment legislation. Assessments of predicted environmental impacts arising from these activities and plans for the management of those impacts must be formulated to fulfil proponents' obligations under those laws. Public notice must also be given so that members of the community may make written submissions in relation to any proposal to establish a waste repository (for radioactive waste or otherwise) in South Australia.

Bearing these issues in mind,

4.5. What are the specific models and case studies that demonstrate the best practice for the establishment, operation and regulation of facilities for the storage or disposal of nuclear or radioactive waste? What are the less successful examples? Where have they been implemented in practice? What new methods have been proposed? What lessons can be drawn from them?

4.6. What are the security implications created by the storage or disposal of intermediate or high level waste at a purpose-built facility? Could those risks be addressed? If so, by what means?

4.7. What are the processes that would need to be undertaken to build confidence in the community generally, or specific communities, in the design, establishment and operation of such facilities?

4.8. Bearing in mind the measures that would need to be taken in design and siting, what risks for health and safety would be created by establishing facilities to manage, store and dispose of nuclear or radioactive waste? What needs to be done to ensure that risks do not exceed safe levels? Can anything be done to better understand those risks?

4.9. Bearing in mind the measures that would need to be taken in design and siting, what environmental risks would the establishment of such facilities present? Are there strategies for managing those risks? If not, what strategies would need to be developed? How would any current approach to management need to be changed or adapted?

4.10. What are the risks associated with transportation of nuclear or radioactive wastes for storage or disposal in South Australia? Could existing arrangements for the transportation of such wastes be applied for this purpose? What additional measures might be necessary?

RISKS & OPPORTUNITIES CONTINUED

If nuclear or radioactive waste was to be stored or disposed of in South Australia, that waste might be sourced from existing waste currently being stored in Australia or overseas. Further, those wastes might be sourced from the future generation of electricity or the use of radioactive materials in medicine, science and industry. If Australia was to construct and operate plants generating electricity from nuclear fuels, waste produced from that source would need to be stored.

The extent of any economic benefit to South Australia associated with the management, storage or disposal of nuclear and radioactive wastes would depend on the needs of those holding wastes either in Australia or overseas. As such, the benefit would depend on the nature of any proposal including the type of waste, the type of facility and the duration for which that waste would be managed or stored. This means that it will be relevant to consider examples of facilities currently being established or being operated, particularly to store intermediate and high level waste, from which relevant comparisons might be drawn. In assessing benefits, it will be necessary to separate economic activity associated with the planning and establishment of the facility from its operation and to understand the circumstances under which the storage of waste is funded by those that generate the waste.

While establishment of facilities for the storage and disposal of nuclear and radioactive wastes would require international expertise and co-operation, there will be a need for domestic specialist training by tertiary and technical providers. Skills required to operate and maintain such facilities would include, for example, nuclear and health physicists, engineers, environmental and geological scientists, managers and transport workers, as well as those with trade related skills.

Just as the extent of any employment opportunities created would depend on the nature of the proposal to store or dispose of waste, so would potential impacts on other sectors of the economy. As a potential trade-off against the economic benefits for payments for waste storage, it has been suggested that establishment of such a facility may have a negative impact on other sectors including tourism and agriculture. It has also been suggested that it may encourage the development of related sectors with specialities related to nuclear activities.

Bearing those matters in mind,

4.11. What financial or economic model or method ought be used to estimate the economic benefits from the establishment or operation of facilities for the storage or disposal of nuclear and radioactive waste? What information or data (including that drawn from actual experience in Australia or overseas) should be used in that model or method?

4.12. Would the establishment and operation of such facilities give rise to impacts on other sectors of the economy? How should they be estimated and what information should be used? Have such impacts been demonstrated in other economies similar to Australia?

[15] ARPANSA, 1985, RHS No. 13, *Code of practice for the disposal of radioactive wastes by the user*, available at http://www.arpansa.gov.au/pubs/rhs/rhs35.pdf.

[16] See for many of the relevant considerations: ARPANSA, RHS 13 - Code of practice for the near-surface disposal of radioactive waste in Australia (1992).

[17] ARPANSA, RPS 2 - Code of Practice for the Safe Transport of Radioactive Material (2008). See also, RPS C-2 – Code of Code of Practice for the Safe Transport of Radioactive Material (2014).

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