CHAPTER 9: TRANSPORT, REGULATION AND OTHER CHALLENGES

TRANSPORT

124. The international transport of radioactive materials, such as mined uranium, processed uranium for nuclear fuels, nuclear medicine and waste, is routine. Consignments are transported safely by road, rail, sea and air.

Each year, about 20 million consignments of radioactive materials are transported worldwide.[1] Isotopes for nuclear medicine make up most of this global activity, with radioactive materials relating to the nuclear fuel cycle representing about 5 per cent of consignments.[2] Many medical isotopes have short 'half-lives', a limit to their effectiveness that makes the use of air transport necessary to deliver the material promptly.

Of the nuclear fuel cycle radioactive materials, there have been approximately 7000 international shipments of used fuel since 1971, comprising more than 80 000 tonnes of material.[3] This includes high level waste from commercial nuclear power reactors, as well as intermediate level waste from research reactors such as the Australian Nuclear Science and Technology Organisation (ANSTO) facility at Lucas Heights in New South Wales. ANSTO has sent a total of nine shipments for reprocessing overseas.[4]

A large proportion of the shipped material has been for reprocessing, including 40 000 tonnes of used fuel at the La Hague facility in France and more than 30 000 tonnes at the Sellafield facility in the United Kingdom.[5]

There are concerns about the safety of used fuel shipments and the risk that an accident would harm people and the environment through radiation exposure.[6] Accidents have occurred during shipments of used fuel, but none has resulted in either a breach of the packages containing the radioactive material or any harmful effects due to radiation.[7] Packages containing used fuel are specifically designed to withstand serious accidents. Past incidents have proven their ability to do so, including at Fukushima in 2011 when eight casks stored in the plant remained intact despite being hit by the tsunami.[8]

In the context of nuclear medicine, approximately 9600 domestic consignments a year are made from ANSTO to hospitals, radiopharmacies and nuclear medicine practices around Australia.[9] There is an equivalent number of intrastate shipments in Australia each year, made using wide-bodied aircraft and handled by certified personnel. The most significant product in these consignments is molybdenum, which is used in about 80 per cent of the world's diagnostic imaging.[10]

125. Uranium oxide concentrate is routinely exported from Australia. While there have been incidents involving damage to containers or drums, there has never been an accident involving the release of radiation that has adversely affected workers, the public or the environment.

Uranium oxide concentrate (UOC) is transported and exported in powder form, which is also known as yellowcake. It has low radioactivity and remains chemically stable during transport, handling and storage.[11] In South Australia, UOC is transported via rail and road from the mine site where it is produced to Port Adelaide, from where it is shipped overseas. About 11 000 containers of UOC have been exported from Australia in the past 30 years.[12]

The UOC for shipment is packaged at the mine site. It is placed in 200-litre steel drums and sealed with a secured lid. The sealed drums are then stowed in sea freight containers and secured using a Kevlar-based system of straps. The container is clearly labelled and sealed with numbered seals at the mine site, ensuring that the container remains sealed from the mine to the final delivery point. The radioactivity of each consignment is measured before it leaves the mine site.[13]

Consignments are inspected throughout the transport process, with any anomalies or incidents being reported, regardless of how minor. Any damage to containers is reported by the transporter to the consignor and consignee, with certified personnel checking for any radiation-related risks. In Australia, the Australian Safeguards and Non-proliferation Office (ASNO) is also informed of these incidents.[14] Figure 9.1 illustrates examples of the incidents that have occurred during UOC consignments.[15]

Figure 9.1: Damage to UOC shipping and packaging containers

Images courtesy of Frank Boulton, Class 7 International

Despite concerns being raised about safety during UOC transport,[16] there has never been an accident in Australia resulting in the release of UOC to an extent that has adversely affected workers, the public or the environment. Incidents do occur; however, these generally result in minor damage to the packaging without compromising its integrity.[17]

126. The transport of nuclear materials is undertaken in accordance with a mature international regulatory regime, which establishes minimum standards for transport packages, including that they are specifically designed to accommodate the physical, chemical and radiological properties of their contents.

The International Atomic Energy Agency (IAEA) has developed international regulations for the safe transport of radioactive material.[18] These transport regulations are applied to the domestic carriage of radioactive materials within IAEA member states. Further, the IAEA regulations are incorporated into rules established by different modal regulators for safe international carriage, including the International Maritime Organisation for sea transport and the International Civil Aviation Organisation in the case of air transit.[19]

Under the regulatory requirements, different types of radioactive material are to be packaged and transported according to their radioactivity level, whereby greater shielding is incorporated to address higher radioactivity.[20] Radioactivity is measured when the materials are packaged by taking readings at the surface of the package as well as 1 metre from the surface.[21]

The five types of packages according to IAEA regulations are: Excepted, Industrial, and Types A, B and C. Excepted packages are used to transport material that has such extremely low radioactivity that it does not present a hazard to people or the environment.[22] Industrial packages are also used for materials with low radioactivity, including UOC, and do not require any specific shielding to be designed into them.[23] Packages rated to Types A, B and C incorporate shielding to address highly radioactive material and, in the cases of B and C, reinforced components for accident resistance (see figure 9.2).[24]

These international standards have been incorporated into a code coordinated by the Commonwealth radiation safety regulator, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), which is applied to transport throughout Australia by state and territory regulators.[25] ASNO is responsible for reviewing and approving a security plan that is in place during a consignment.[26]

127. Shipments of used fuel are routine. They are undertaken in accordance with international requirements that address the risks associated with the heat and radiation that the fuel produces.

Used nuclear fuel is transported in Type B packages, which are comprehensively engineered products each weighing more than 100 tonnes when filled (see Figure 9.2).[27] As loaded used fuel packages emit some external radiation, their routine transportation results in very small doses of radiation to the public along the route travelled.[28] These doses are some tens to hundreds of thousand times lower than the levels of naturally occurring background radiation.[29]

The transportation packages undergo rigorous testing to ensure they retain their integrity during numerous operational conditions, thereby reducing the potential for any release of their radioactive contents during an accident.[30] The testing standards are set by the IAEA transport regulations and involve:[31]

- dropping the package on to an unyielding surface and a steel vertical bar from a height of 9 metres
- submerging the package under 15 metres of water for eight hours and 200 metres of water for no less than one hour
- subjecting the package to an all-engulfing fire at 800 degrees Celsius for 30 minutes.

Arguments have been advanced that these testing requirements are not sufficiently rigorous and the conditions a package might be exposed to in an accident are potentially more damaging.[32] The testing regime is directed towards ensuring that any given package design is capable of withstanding accident conditions that are reasonably expected to occur.[33] Further, the tests are cumulative and the same package is subjected to each exercise outlined above.[34] Demonstrations have shown that the packages are capable of withstanding actual accidents.[35]

In most accident scenarios that could occur during international shipments of used fuel, it is unlikely that an actual accident would be more severe than the tested conditions.[36] The exception is if a package were lost in deep water. In that event, it is considered unlikely that the package would fail completely, as water ingress would cause the pressure to equalise.[37] Even were a package to be lost in coastal waters and leach radioactive material into the ocean, studies have estimated that the resultant dose to the maximally exposed individual as a result of eating only contaminated seafood, would be 0.00041 millisieverts per year (mSv/a).[38]

The modal standards that apply to ships carrying used nuclear fuel are outlined in the International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships (INF Code). The code incorporates ratings of INF 1, INF 2 and INF 3, where INF 1 can carry the least amount of material and INF 3 has no limit.[39] Ships meeting the INF 3 rating are specifically engineered for the transport of used nuclear fuel packages. There are at least five small INF 3 ships (1250–2200 tonnes in mass) and four larger, purpose-built INF 3 ships (3800–4900 tonnes in mass) that operate globally.[40]

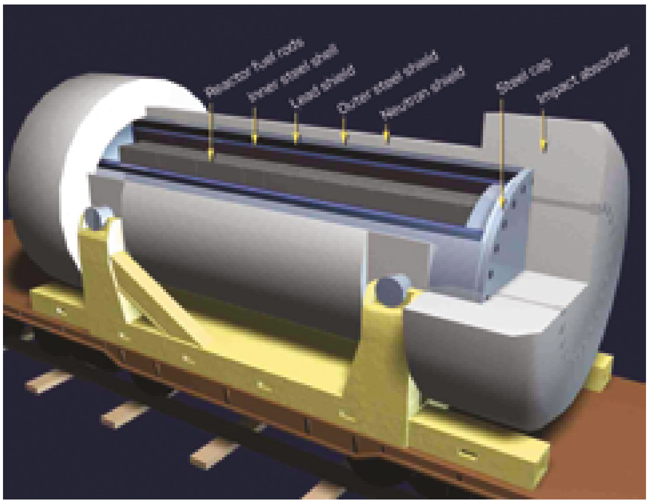

Figure 9.2: A generic Type B transportation cask on a rail bogie

Image courtesy of Nuclear Energy Institute

To be classified as INF 3, ships must meet a range of requirements concerned with safety and security, as illustrated in Figure 9.3. These standards are often exceeded with additional measures to improve a vessel's ability to withstand an accident, such as double hulls.[41] Further procedural measures also are incorporated to address security risks, such as restricting access to the cargo holds and navigating the vessel to avoid known areas of conflict. When the nuclear material being transported presents a greater security risk (such as highly enriched uranium [HEU] or plutonium), armed guards are present throughout the voyage. In any event, theft of the cargo would be extremely difficult, given its weight and the need to use a heavy crane to extract it from the holds.[42]

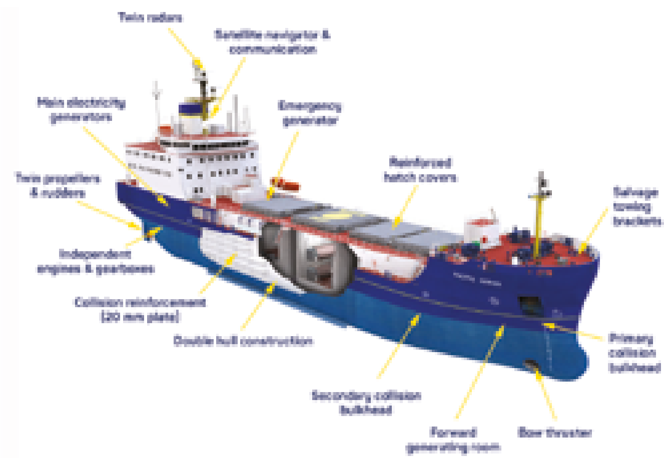

Figure 9.3: A schematic of an INF 3-rated ship, purpose-built to transport used nuclear fuel packages

Image courtesy of Pacific Nuclear Transport Limited

Bilateral arrangements are entered into so that the transport process and responsibilities of the consignor and consignee are well understood. The agreements establish handover protocols between the consignor, the operator of the vessel and the consignee to ensure security is maintained throughout the voyage.[43] Transport plans ensure that approvals are obtained for the use of the embarkation and destination ports before the voyage starts.[44] In addition, transport ships are generally designed to be able to carry their cargoes to their destination via any route without needing to stop.[45]

As a party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, Australia is required to ensure, during any transboundary movement of used fuel or radioactive waste, that people and the environment are protected from any potential hazards presented by these materials.[46]

If facilities were to be established in South Australia for the storage and disposal of used fuel, a number of accident scenarios could conceivably take place while the spent fuel is being transported. On the basis of extensive international studies and experience in transporting used fuel, and the range of regulatory measures discussed earlier which are directed towards its safe transport, analysis has been undertaken to estimate the likelihood of a range of incidents occurring in the context of South Australian facilities. During normal transport conditions via sea, rail and road, there is a low probability that an accident would occur with the potential to damage the transport package.[47]

In the unlikely event of such an accident, studies demonstrate there is a very low probability that the package would be perforated, causing a release of radioactive material.[48] Studies also show, however, that small amounts of radioactive material could be released in the event of an exceptionally severe, and extremely low probability,[49] impact accident, causing damage to the seals between the cask lid and walls. Such a release could only occur in transport packages that contained directly loaded used fuel (that is, with no inner steel welded canister containing the used fuel rods),[50] unlike the cask depicted in Figure 9.2, which contains an inner steel shell and would likely be the preferred design for any proposed transportation in Australia. In such an event, any resultant radiation exposure to people and the environment would depend on population density proximate to the accident site at the time. If emergency response and radiation protection measures are implemented swiftly following such an accident, exposure to members of the public is likely to be limited.[51]

As it is envisaged that new dedicated port, rail and road infrastructure would need to be established to service any storage and disposal facilities, it would be possible to design and site them in a way that supports the safe transport of used fuel.[52] This would further limit the potential for any serious incidents and their radiological consequences.

REGULATORY OVERSIGHT

128. Effective regulatory oversight of nuclear activities is principally required to:

- **a. protect workers, the public and the environment from the harmful effects of radiation**
- **b. physically secure nuclear material against theft or unlawful use**
- **c. safeguard against the proliferation of nuclear weapons**
- **d. provide public confidence that the activity is properly and safely managed.**

Given that ionising radiation presents particular health and environmental hazards, it is appropriate for government to develop industry-specific policies and laws to ensure safety, including the safe handling, transport and use of radioactive materials.[53] Such laws and policies need to be designed to limit occupational and incidental human exposure to radiation to accepted safe levels, including by preventing the release of radioactive material into the environment, where it can enter the food chain. Because certain types of radioactive material have the potential to be used in the manufacture of nuclear weapons, legal restrictions on the possession, handling and sale of such material are also needed to ensure its use is solely for peaceful purposes.[54]

The extent of policies, laws and other regulatory instruments required would depend on the nature of the activities or facilities in any jurisdiction. Such laws and policies would require transparent and robust implementation and enforcement to encourage compliance by industry, and provide assurance to the general public that the potential hazards are being actively managed.[55] This includes the requirement for approval in advance of the construction and operation of nuclear facilities and transport of radioactive materials, along with ongoing compliance monitoring from an independent and trusted regulatory authority.[56]

129. The existing regulatory framework at state and federal level for the purposes of radiation protection, security and non-proliferation is appropriate for the limited scope of nuclear activities currently undertaken in South Australia.

The activities that require radiation protection measures comprise uranium mining and milling operations, centres for nuclear medicine research and treatment such as universities and hospitals, and some industrial manufacturing using sealed radioactive sources, for example, specialised bulk material analysers.[57] The development and operation of such nuclear facilities, and the associated transport of radioactive materials, are subject to federal and state laws. These Acts comprise the principal legislation at the federal level[58]:

- The *Environment Protection and Biodiversity Conservation Act 1999*, requires the federal Minister for the Environment to approve in advance certain 'nuclear actions', including uranium mining.
- The *Australian Radiation Protection and Nuclear Safety Act 1998* (ARPANS Act) establishes ARPANSA, which develops the national codes of practice for protection from the harmful effects of radiation based on international requirements and promotes their uniform application by state and territory regulators. That Act creates a regulatory regime for the licensing of the possession of certain radioactive materials, and the construction, operation and decommissioning of 'nuclear installations', by or on behalf of the Australian Government.
- The *Nuclear Non-Proliferation (Safeguards) Act 1987*, which creates a regulatory regime of permits for the possession and transport of nuclear materials, and the establishment of nuclear facilities, to ensure that appropriate measures for the safeguarding and security of nuclear materials can be put in place. This regulatory framework is based on internationally recognised standards and fulfils obligations under treaties and conventions that Australia has ratified.

At the state level, the *Radiation Protection and Control Act 1982* (SA), administered by a special team in the South Australian Environment Protection Authority (EPA),[59] applies consistently with the ARPANS Act to ensure that exposure of persons to radiation is kept to as low as reasonably achievable. A bespoke regime for radiation protection applies to uranium mining and milling activities at the Olympic Dam mine pursuant to the *Roxby Downs (Indenture Ratification) Act 1982* (SA).[60]

While the Commission has received a submission and a response to the Tentative Findings that are critical of the existing regulatory regimes,[61] there was no credible evidence to suggest these regulatory regimes were inadequate to appropriately protect workers, the public and the environment from the hazards of ionising radiation presented by the nuclear activities undertaken in South Australia.

The Commission considers that the existing requirements relating to security and non-proliferation are effective in ensuring, as far as possible, the application of Australian radioactive material for peaceful purposes only. For further discussion see Chapter 8: Non-proliferation and security.

130. Regulatory frameworks would need to be developed for new activities that are not presently undertaken in South Australia.

Existing federal and state legislation prohibits the establishment in South Australia of further processing facilities for nuclear fuel, nuclear power plants and international nuclear waste storage and disposal facilities.[62] Depending on the type of facility proposed, legislative amendment at one or both levels of government would be required before a proposal for any such facility could be progressed.[63]

Engagement in such activities would require changes to the existing regulatory frameworks to address specific hazards. In particular, it would be necessary to develop and implement a regulatory framework for the approval in advance of the design, construction and operation of any proposed facility, including the associated transport of radioactive materials.[64] This is typically done by requiring a proponent to obtain a licence from an independent expert regulator before each step.[65]

The regulator and licensing process would require sufficient legislative underpinning to ensure all aspects of the proposal were able to be tested and verified to a standard that would give the public confidence about the safety and security of the proposed facility at each stage of its development.[66]

Such arrangements would need to be in place well in advance of any licence application being contemplated to ensure the regulator is appropriately resourced to manage pre-licensing discussions with potential proponents and any resulting licensing process.[67] Sound working relationships with related government and other stakeholders (for example, customs and emergency services) would also need to be established.[68]

Core competencies of regulatory staff would include technical, organisational, communications and legal expertise.[69] The engagement of a technical support organisation to advise and assist in the initial stages should be considered where appropriate.[70]

131. Effective regulatory oversight of nuclear activities not presently undertaken in South Australia requires the regulator to be:

a. independent of both industry and the executive government

b. transparent and consistent in its decision making

c. committed to safety, and encouraging a safety culture, in all aspects of its operations

d. supported by, and welcoming of, international advice and peer review, including that provided through the International Atomic Energy Agency.

The safe and secure operation of any nuclear facilities would need to be the cornerstone of regulatory decision making.[71] To ensure this, the regulator would need to be able to make judgements and provide independent advice to government, free from political or economic pressures.[72] While regulatory staff would need to be appropriately qualified and experienced, they should not have any interest, direct or indirect, in the activities to be assessed.[73] The actual and perceived independence of the regulator would be essential to maintaining the public's trust and confidence in the regulatory process.[74]

Similarly, the respect and confidence of all stakeholders, including the public, in regulatory decision making would be increased where the regulator's processes are transparent and decisions coherent and consistent.[75] The regulator should be designed, established and operated to encourage scrutiny and informed debate with respect to its activities and decisions, from both its own ranks and external sources. The goal should be continuous improvement, particularly with respect to safety concerns.[76]

As nuclear activities including further processing, power generation and high-level waste storage and disposal would be novel to Australia, any new or expanded regulatory regime would need to draw heavily on international experience.[77] Peer reviews, including as part of the Integrated Regulatory Review Service offered by the IAEA, should be encouraged and acted on by the regulator.[78] Consideration should be given to establishing an international advisory body to provide ongoing review and advice to the regulator.[79]

In relation to high level waste storage and disposal facilities, any regulatory arrangements established would need to provide for an appropriately resourced, trusted and independent regulator. A regulator would need to be capable of assessing in detail the safety of any facility proposal put forward by a project proponent, in order to authorise further activity at particular stages of any project. The role of such a regulator would commence well in advance of any licence being sought, and would involve liaising constructively with the proponent in the development and evolution of a safety case, The role would include providing coherent and reliable information to the community as to the regulatory requirements and project progress. Once a licence was granted, the regulator would be required to monitor facility construction and operation to the level required to ensure safety.[80]

132. The types of nuclear fuel cycle activities proposed would be critical to the division of responsibility between the federal and state governments when expanding the regulatory infrastructure.

As matters of international concern, nuclear safety and security are the subjects of many treaties and international bilateral agreements, to which Australia is a party.[81] The Australian Government therefore has an ongoing role to ensure the standards set out in these international instruments are met.[82]

Were South Australia to host a new nuclear facility, the state government would also have a significant interest in ensuring that safety and security risks are properly managed.

Therefore, it is likely that both federal and state legislation and regulation would be required, as would close coordination between the two spheres of government.[83]

Irrespective of whether a new or expanded regulatory regime is established at federal or state level, or both, the ongoing presence of key regulatory staff in South Australia would be likely to assist in building and maintaining the public's trust and confidence in the regulator's processes and decisions.[84]

133. There are choices in terms of regulatory design.

Different regulatory approaches affect the requirements placed on potential proponents.[85] Outcomes-based approaches establish specific performance goals or outcomes for proponents to attain, but do not specify how they must be attained. In contrast, prescriptive approaches establish specific requirements for proponents and their activities, including proposed technical and other processes for meeting those requirements.[86] Each approach has benefits and difficulties. In practice, and consistent with IAEA requirements,[87] nuclear industry regulators around the world employ a graded range of adapted processes appropriate to the relevant activity and the nature of the associated safety or security risk.[88]

The preferred regulatory approach to creating and enforcing safety requirements would need to be determined following consultation and agreement between relevant state and federal government agencies, to ensure a coordinated approach. Irrespective of the approach chosen, it would need to be established in, or be clearly implicit from, the regulator's founding legislation. This would support consistent and coherent regulatory decision making, creating an environment in which potential proponents, the public and the international community have confidence in the process. This would be essential for any proposed new nuclear facility, both in encouraging investment and maintaining social consent.[89]

134. The regulatory structure should be flexible enough to allow advantage to be taken of credible overseas licensing processes of similar proposals or technologies.

While it is important that overarching policy, foundation legislation and a framework for the preferred regulatory approach be settled early, detailed requirements and guidance for particular activities could be developed by the regulator in parallel with any project proposal contemplating those activities.[90]

The benefit of international experience and expertise should be harnessed as far as possible. For example, relevant aspects of regulatory instruments or decisions from experienced overseas regulators could be adopted where applicable to the contemplated facilities or activities in the South Australian context.[91] The United Arab Emirates (UAE) Federal Office for Nuclear Regulation took this approach as part of the regulatory approval process for its recently established nuclear power program.[92] The UAE's experience shows this approach can be effective and efficient for some technical aspects of facility design and operation, but would have less application to site-specific considerations.[93]

It would be critical that all regulatory decision making relating to safety and security, particularly if based on analysis by overseas authorities, is justifiable and communicated to government and the public.[94]

INVESTMENT

135. There is significant appetite in the private sector investment community to support new Australian infrastructure projects.

136. Securing investment in energy market infrastructure in Australia has been challenged by significant policy uncertainty and a sustained period of falling demand.

Private sector investors consider Australia to have a strong and established infrastructure market, with significant appetite for direct investment in large infrastructure projects.[95] However, projects perceived to be politically sensitive and lacking stable bipartisan support from both federal and state governments would not be attractive to potential investors.[96]

In the absence of such support, securing investment in a nuclear infrastructure project would be challenging, given that it is perceived as being particularly risky due to technical and regulatory complexity combined with potentially long payback periods on a large initial capital outlay.[97]

Further, political and sovereign risk, as evidenced by policy changes affecting previous commitments of governments at the state and federal levels in Australia, remains a primary concern.[98] In deregulated energy markets such as Australia's National Electricity Market, the uncertainty surrounding both long-term wholesale prices and falling demand has made investment in new generation infrastructure particularly challenging.[99] Stable policy and regulatory support, including financial incentives through mechanisms such as the Australian Government's Large-scale Renewable Energy Target or the United Kingdom's Contract for Difference arrangements, have been necessary to stimulate such investment.[100]

Such incentives provide a revenue stream from a credible and accessible market.[101] Where private sector investment would be required to underpin any proposed new nuclear facility in South Australia, consideration should be given to establishing enabling regulatory mechanisms.[102] Such mechanisms should support a credible market-based pathway towards the timely repayment of reliably estimated costs, with a sufficient return.[103]

INSURANCE

137. Insurance for nuclear activities in Australia is provided under a series of specific arrangements, in the absence of a need for a comprehensive nuclear liability regime.

Activities at nuclear facilities present the risk of an accident and the potential for loss and damage to be suffered. The severity and consequence of the accident depend on the type of facility. These can range from catastrophic impacts of major nuclear power plant accidents causing significant releases of radioactive material, to minor accidents during routine transportation of radioactive material causing no harmful radiation releases, such as those discussed at Finding 125. Accordingly, appropriate insurance arrangements to cover potential accidents and their consequences vary, depending on the facility.

The activities undertaken in Australia—the mining, milling and transport of uranium oxide, and the transport of small amounts of sealed radioactive sources for medical, industrial and research purposes—have very limited potential to result in damage from the release of ionising radiation. For that reason, a statutory nuclear liability and insurance regime has not been required.[104]

A site-specific arrangement applies to ANSTO's Open Pool Australian Lightwater (OPAL) research reactor at Lucas Heights in New South Wales, in that the Australian Government has indemnified the organisation and its contractors against any claim for damage allegedly caused by ionising radiation.[105] Such an arrangement would not be appropriate for new commercial nuclear activities such as power generation, particularly where private sector entities are involved.[106]

Any new type of nuclear fuel cycle activity, such as conversion, enrichment, fuel fabrication, power generation or waste storage and disposal, undertaken in South Australia, whether by a private sector or government proponent, would require appropriate arrangements to ensure adequate cover for damage caused in the event of an accident. Before the development of any such facilities, it would be necessary to ensure the international nuclear liability conventions are implemented into a domestic statutory regime.[107]

138. An existing international regulatory framework provides guidance for compensating victims of damage from nuclear processing, power generation, and waste storage and disposal.

139. The amount of commercial insurance cover mandated by the international agreements is apparently inadequate to fully compensate victims and remediate the environment in a catastrophic scenario at a nuclear power plant, although that is not the case with respect to accidents at other nuclear facilities.

A number of longstanding international conventions govern nuclear insurance.[108] Australia has not ratified these conventions.[109] However, in the event of new nuclear activities, ratification and domestic legal implementation of one or more of these conventions would be required to comply with the IAEA recommended regime for nuclear insurance and to provide certainty for potential participants about the applicable insurance arrangements.[110]

To implement the convention principles, any domestic legislation would need to include:

a. a defined scope for the liability regime, in terms of the type of damage that is covered

b. strict and exclusive liability channelled to a designated operator

c. mandatory minimum insurance requirements for designated operators

d. exclusive jurisdiction of the courts of the state in which the incident occurred.[111]

The conventions allow for the liability of designated operators to be capped, which has been controversial as it is perceived as protecting industry to the potential detriment of the broader public. Many countries have chosen not to implement liability caps, theoretically making liability unlimited.[112] In practice, the amount that could be recovered from a designated operator would be limited by the value of its assets and insurance policies.[113] A legislated requirement that a designated operator hold a certain amount of insurance would therefore be critical to public confidence that a meaningful level of compensation would be available if required.

The appropriate minimum level of insurance cover would be a balance between the potential cost of accidents relevant to the particular nuclear activity, and the availability and cost of insurance cover to a particular level.[114]

In the event of a nuclear catastrophe such as occurred at Chernobyl in 1986 and Fukushima Daiichi in 2011, the amount of compensation required would far exceed the minimum insurance limits required under the international conventions, and indeed the amount of insurance cover likely to be available on the commercial market.[115] It is inevitable in such scenarios that the state would pay additional compensation or take responsibility for environmental remediation. Beyond a certain level, therefore, it must be accepted that the consequences of a catastrophic accident at a nuclear power plant are effectively socialised.

That is not the case for an accident at a conversion, enrichment, fuel fabrication, or waste storage and disposal facility, including during transport of radioactive materials associated with these activities. The International Expert Group on Nuclear Liability has concluded that the minimum insurance required under the conventions are likely to be adequate, even in the case of a transport accident involving high level waste.[116] Despite this, it would assist in maintaining public confidence in the management and operation of any such nuclear facilities in this state to understand that a certain amount of any profits derived were quarantined for potential compensation and remediation in the event of an accident, even if not required.

140. A commercial market for insuring nuclear fuel cycle operations is available internationally. This market can be accessed in respect of an Australian facility.

Because most commercial insurers do not cover the risk of a nuclear accident,[117] a specific nuclear insurance industry has developed, which includes a number of insurance pools that would support each other if required to pay out the full amount of cover for any particular facility.[118] It would be possible for a local facility to access insurance that is underpinned by relevant international providers in Europe, particularly the United Kingdom. The necessity to establish a domestic nuclear insurance pool would depend on the scope and scale of any potential expansion of Australia's nuclear industry.[119]

EDUCATION AND SKILLS DEVELOPMENT

141. Building up a sufficient level of local nuclear engineering expertise requires time, commitment and planning. Skills planning, such as has been incorporated into international programs to develop major nuclear projects, would be necessary to ensure an appropriately skilled workforce was available.

Careful planning years in advance of the construction of a nuclear facility would be essential to ensure an appropriately skilled local workforce is available for all stages of the project.[120] The early identification of skills gaps is central to such planning.[121] Extensive skills planning has been integral to international programs for the development of major nuclear projects, most notably for nuclear power where workforce requirements have been analysed (see Figure 9.4).[122] For example, in preparation for expanding the nuclear power program in the United Kingdom, the government established a specific group, the Nuclear Energy Skills Alliance, to closely assess current nuclear skills gaps, future skills needs, and plan for skills delivery across all sections of the nuclear workforce.[123]

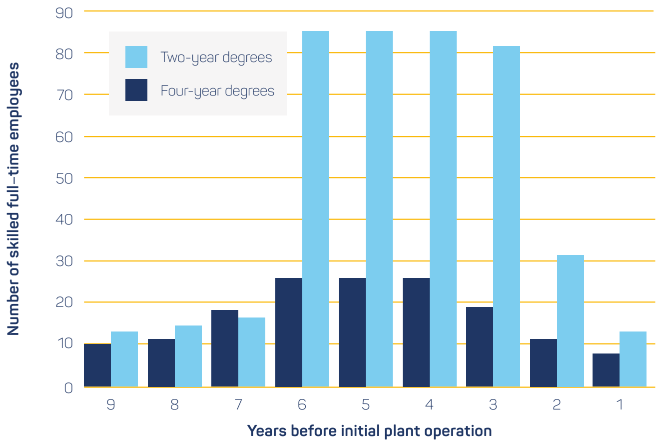

Figure 9.4: Timing of workforce employment before nuclear power plant operation

Data sourced from Nuclear Power Institute, Texas A&M University, 2014

A strong commitment to the project from state and federal governments would be critical to the higher education sector's ability to plan and develop the necessary programs and attract students to the industry.[124]

Due to Australia's limited experience in commercial nuclear activities, it may be necessary during early stages of planning to import a small proportion of specialised nuclear skills from jurisdictions with advanced nuclear industries while the local workforce develops the necessary competencies.[125] Skills planning should also take into account the time required for enhancement of local skills through practical training at overseas nuclear facilities.[126]

142. With some additional skilling, Australia's engineering and technical workforce would be a sound base for the construction of new nuclear fuel cycle facilities. Additional skilling would be necessary to meet the more exacting standards of the nuclear industry.

Australia has an established workforce with a range of skills applicable to the planning, construction and operation of large, complex industrial projects.[127] Many existing competencies are applicable to the construction of any new nuclear facilities in South Australia.[128]

Were South Australia to embark on a new nuclear development, further education and training of Australia's existing workforce would be necessary to ensure higher nuclear standards were met.[129] The installation of new nuclear facilities requires more exacting standards of safety,[130] quality and transparency than those required for large infrastructure projects in other industries, such as oil and gas.[131] Heightened attention to detail and quality is a particular imperative in the planning, construction and operation of nuclear power plants due to the specific safety risks inherent in the generation of electricity from nuclear fuel.[132]

The nature of the nuclear competencies required, and the associated extent of upskilling, would depend on the type of nuclear facility planned.[133] Some facilities similar to other advanced manufacturing and industrial processes already in Australia would require less extensive additional education in nuclear science than,[134] for example, nuclear power reactors, which require more specialised skills.[135]

The existing platform for upskilling includes trade skills such as concreting, electrical, carpentry and welding; broad engineering capabilities, particularly from within the electricity generation and oil and gas industries; and high-level project management and regulatory skills in various technologically complex and hazardous industries such as oil and gas, and aerospace.[136]

Relevant lessons on accessing and building necessary capabilities locally can be drawn from ANSTO's construction of the OPAL research reactor. That experience demonstrated that sections of Australia's existing workforce are capable of filling key roles in the construction of a nuclear reactor, and also highlighted the necessity to ensure the local workforce is trained in accordance with, and able to deliver, the highest standards of quality required for nuclear new builds.[137]

143. Australia's existing base of nuclear engineering capability would need to be enhanced should additional nuclear activities be pursued.

While technical and trade-based personnel would make up a significant proportion of the workforce during the construction phase of a nuclear project, a contingent of nuclear engineers with specialised knowledge and experience would need to be available early in the process. Such nuclear-educated professionals would serve a critical role from the outset by ensuring safety and quality of design, construction and operation, in addition to ongoing complementary research and development.[138] Australia has a relatively modest base of nuclear science and engineering expertise, primarily associated with the activities of ANSTO.[139] This base would need to be expanded and tailored to the particular facility under development through further education and training programs.[140]

The two university-level postgraduate nuclear engineering and science-based programs offered in Australia, which presently accommodate limited student numbers and are relatively broad in content,[141] could provide platforms to support the expansion of the nuclear engineering skill base.[142] There may also be scope for other Australian universities to offer further nuclear education programs, depending on demand.[143]

A partnering program with international universities that offer high quality nuclear engineering courses could augment existing Australian courses to deliver the specialised content required and ensure that local courses address contemporary international developments in the nuclear industry.[144] Such partnerships would be most beneficial when established with the overseas institutions that have leading expertise and practical experience in development and operation of the particular facility contemplated. Several Australian universities already have experience developing such international connections in nuclear education programs.[145]

Establishing educational networks or consortiums between higher education and research institutions at the national, and potentially regional or international levels, would enable high-quality specialised nuclear education to be delivered by a number of institutions coordinated under the one program. Under this model, students would have the benefit of access to a wider range of educational resources from multiple universities or institutions. The effectiveness of the network or consortium approach to address future nuclear skills needs has been demonstrated in several countries, including the United Kingdom, Canada and Belgium.[146]

Research and development capabilities would also need to be enhanced through centres of excellence to support innovation and continuous learning on topics of significance to the planned nuclear facility.[147] Australia has significant experience in, and well established frameworks for, building research and development capacity in scientific areas, particularly those which have been identified by the government as priority.[148] Such centres might also be developed through partnerships or networks abroad.

144. In planning for the development of a geological disposal facility, a proponent would need to engage early with South Australian educational institutions to address the skills required throughout the facility's lifetime. It would be important for South Australian universities, in developing local programs to provide the requisite skills, to collaborate with universities overseas that have strong research capabilities focused on used nuclear fuel management and connections with their national used fuel and high level waste disposal industries.

In light of Findings 80 to 95, were South Australia to develop a geological disposal facility for international used fuel, the proponent would need to plan early, in collaboration with South Australian educational institutions, for the specific skills required throughout the facility's life. Many of those skills, such as community engagement, project management, regulatory and legal, and safety case development, would need to be available from the outset and throughout the life of the project.[149] The project stages and associated capabilities would include:[150]

- legal and organisational aspects—skills required for community engagement, legislative changes, legal and contractual matters, and establishment of a robust regulatory regime for licensing and oversight of the facility throughout its lifetime
- site characterisation—skills in engineering, geology, hydrology, seismology and meteorology for assessing the potential long-term evolution of the site and to establish an underground rock laboratory
- design—engineering and modelling skills for the design of the packaging and disposal concept and development of the safety case for licensing; and knowledge of the behaviour of spent fuel and radiation protection
- waste acceptance—skills in engineering, chemistry and radiochemistry for setting acceptance criteria and designing and testing of packages
- construction—technical and trade skills (including in underground mining) required for site preparation and construction of the facility and associated infrastructure; and nuclear quality assurance and safety skills
- operation—skills required for transport, handling and emplacement of waste packages; maintenance; radiation protection; nuclear security; and nuclear materials accounting[151]
- closure—skills in radiation protection and monitoring for the required period and in interacting with stakeholders, including the community.

As noted, while some of these skills are available in Australia, including in South Australia[152], many of the specialised nuclear skills required for the management and disposal of used nuclear fuel, in particular with respect to the more exacting standards of nuclear safety and radiation protection, would need to be developed.

South Australia's universities could deliver the education programs through a master's-level course capable of providing the nuclear competencies required by the nuclear waste disposal industry. Existing science, technology, engineering and maths-based undergraduate courses would provide sound platforms for developing postgraduate nuclear programs.[153] Collaboration with overseas universities that supply graduates with scientific and research skills to used fuel management and disposal industries would be essential to ensure that courses delivered locally adhere to the highest international standards and latest industry developments.[154] This could facilitate placements or exchange programs to enable South Australian students to gain practical training and experience in developing and operating geological disposal facilities abroad.

IMPACTS ON OTHER SECTORS

145. There is no compelling evidence that the development of nuclear facilities in South Australia would adversely affect other economic sectors, provided those facilities are operated safely and securely.

The risks arising from the normal operation of a nuclear facility, including on other economic sectors, are low and can be managed. However, there are perceptions that any new nuclear developments would pose risks to the tourism, food and wine industries, and to property prices.[155]

South Australia's existing engagement in the nuclear fuel cycle through uranium mining and managing its low level radioactive waste has not been shown to be detrimental to other sectors. However, the Commission has received submissions warning of reputational damage to South Australia's clean, green image from further participation in nuclear activities.[156] This assertion is difficult to accept given the experiences of countries with significant activities at all stages of the nuclear fuel cycle, which have world-leading industries in tourism and agriculture, including aquaculture and viticulture, including France and the USA.[157]

The Commission considers that the state's reputation as a tourist destination and trading partner could be maintained were a new nuclear activity to be developed.

In South Australia, it is the perception of a potential impact that would need to be addressed in the course of a consent-based siting and licensing process should a development be proposed. Targeted, informative and fact-based discussions with potentially affected stakeholders would assist.

A major nuclear accident resulting in the widespread dispersal of radioactive material would have profound regional impacts. However, such catastrophic consequences are conceivable only in the event of a serious accident at a nuclear power plant. With respect to managing radioactive waste in a highly engineered and specifically designed storage and disposal facility, the risks and potential consequences of an accident are different and lower. Facility siting would also take into consideration a wide range of factors, including any potential economic and social impacts. Nevertheless, community perceptions are important. The community must fully understand the nature of the proposed activity and be provided with objective, factual information about the risks involved, in order for community perceptions to move beyond fear-based assumptions that such a facility is a 'dump'.[158]

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