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Convention on Nuclear Safety

Australian National Report

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Australian Government

Australian Radiation Protection and Nuclear Safety Agency

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Introduction

National nuclear activities

i. Australia ratified the Convention on Nuclear Safety (the Convention) in December 1996. Since then, Australia has submitted National Reports to, and actively participated in, every review meeting. The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is responsible for reporting on how Australia meets its obligations under the Convention.

ii. Australia does not have any "nuclear installation" as defined in the Convention but has one operating research reactor (OPAL). Another research reactor (HIFAR) has been permanently shut down and all fuel elements have been removed. The decommissioning program is not fully developed and decommissioning activities have not commenced. Both OPAL and HIFAR are managed by the Australian Nuclear Science and Technology Organisation (ANSTO) – an Australian Government entity - and are regulated by ARPANSA. Both reactors are located at the Lucas Heights Science and Technology Centre south of Sydney in the State of New South Wales[1].

Recent developments

Nuclear power

iii. The Australian Government does not currently plan to establish nuclear power plants. In fact, the *Australian Radiation Protection and Nuclear Safety Act 1998* (the Act) prohibits the CEO of ARPANSA from authorising the construction or operation of nuclear power plants. Many Australian States and Territories have similar prohibitions. However, two recent developments merit mention. These are the report[2] of the South Australian Nuclear Fuel Cycle Royal Commission in May 2016 into the potential for increasing South Australia's engagement in nuclear fuel cycle activities and the Australian Government's Energy White Paper[3] in April 2015.

iv. In relation to nuclear power, the Royal Commission found sufficient evidence of safe operation internationally to conclude that nuclear power should not be discounted as an energy option on the basis of safety. However, under current electricity market circumstances, it would not be an economically viable option for South Australia, said the Commission. Nevertheless, it recommended the South Australian Government pursue removal of existing legislative prohibitions on nuclear power generation to allow nuclear power to contribute to a low-carbon electricity system in future, if required.

v. The Energy White Paper noted that some stakeholders are opposed to nuclear energy as it is costly. They claim that it requires significant amounts of water and radioactive waste disposal is a problem. However, there is support in some quarters for nuclear power. At the time of writing this report, the South Australian Government is undertaking consultations with its citizens and is expected to respond to the findings of the Royal Commission towards the end of 2016. The Federal Government is expected to respond shortly after that.

1 Australia is a federation of six States and 2 self-governing Territories
2 See http://nuclearrc.sa.gov.au/
3 See http://ewp.industry.gov.au/

vi. In April 2016, Australia was approved as a member of the Generation IV International Forum (GIF), a co-operative international endeavor, joining 12 other nations and the European Union to work on long-term research on advanced nuclear technologies, including the construction and operation of the next generation of nuclear power reactors.

Waste management

vii. ARPANSA authorised an interim waste store (IWS) at ANSTO in November 2015. The IWS will temporarily store intermediate level vitrified radioactive wastes that have been returned from France following the reprocessing of used fuel assemblies from HIFAR, and operational waste (used equipment and other wastes) generated during the reprocessing. The intention is to move the wastes to the planned National Radioactive Waste Management Facility (NRWMF) when the facility is available.

viii. In April 2016, the Australian Government announced Barndioota in the State of South Australia as the potential site for the proposed NRWMF. This facility is envisaged as a co-located storage and disposal facility for intermediate and low level wastes respectively. The announcement followed extensive community consultation and preliminary studies after the voluntary nomination of 28 sites under the terms of the *National Radioactive Waste Management Act 2012*. Further public and stakeholder consultation is underway.[4]

ix. Meanwhile, the South Australian Royal Commission has recommended that the South Australian Government pursues economic opportunities from the establishment of used nuclear fuel and intermediate level waste storage and disposal facilities in South Australia. The South Australian Government is currently undertaking public consultation on this issue (see paragraph v above).

Action taken from lessons learnt from the Fukushima Daiichi accident

x. A safety reassessment of OPAL in the light of the accident at the Fukushima Daiichi Nuclear Power Plant was performed in accordance with the guidance contained in IAEA Safety Report Series No.80, *Safety Reassessment for Research Reactors in the Light of Accident at the Fukushima Daiichi NPP*.

The rest of this report is a self-evaluation of Australia's compliance with the obligations of the Convention in relation to the two research reactors mentioned above, namely OPAL and HIFAR. The report also updates information contained in Australia's last national report[5]. The reporting format is based on the Articles in the Convention and is in accordance with IAEA guidelines[6]. The paragraph numbering corresponds to the Article numbers of the Convention.

4 See http://www.radioactivewaste.gov.au/

5 http://www.arpansa.gov.au/AboutUs/Collaboration/nucsafety.cfm

6 IAEA Information Circular, INFCIRC/572/Rev.5 dated 16 January 2016

Summary

1. The following is a list of general matters covered in this report.

   a. This report deals with the three Principles in the Vienna Declaration in respect of the OPAL reactor. Principle 1 on design, siting and construction is addressed in Articles 17 and 18. Principle 2 on ongoing safety assessments is covered in Article 14, and Principle 3 on the application of IAEA Safety Standards is covered in Articles 7 and 10.

   b. This report also includes submissions, where relevant, on the challenges identified by the Special Rapporteur in paragraph 35 of the Summary Report of the 6th Review Meeting. These are reported under Articles 6, 8 and 19.

   c. Australia is planning to host an IAEA Integrated Regulatory Review Service (IRRS) mission in late 2018. Australia last hosted an IRRS mission in 2007, with a follow-up mission in 2011. Details of these missions were reported in previous national reports. Most of the recommendations from those missions have been implemented.

   d. All international review reports and Australia's national reports under the *Convention for Nuclear Safety* and the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* are published in the ARPANSA website.[7]

2. A snapshot of new information in this National Report is provided below under the Article in which it is reported.

Article 6 - Existing nuclear installations

3. No significant safety issue in relation to OPAL was raised at the last Australian national report in 2013. There has been no significant safety issue at the OPAL reactor in the current reporting period (2013 to 2016). Nevertheless, requirements for ongoing periodic safety and security reviews (PSSR) were included in the revised operating licence for OPAL in March 2015.

4. In late 2014, the Australian Government introduced the Regulator Performance Framework, under which regulators (including ARPANSA) that administer, monitor or enforce regulations are required to undertake annual self-assessments and report on how they have administered regulation fairly, effectively and efficiently.

Article 7 – Legislation and regulatory framework

5. The *Australian Radiation Protection and Nuclear Safety Act 1998*, which enables the regulation of the OPAL reactor, was amended in 2015 to provide the CEO with additional powers to direct a licence holder, issue improvement notices, and compel the provision of information.

6. The last national report stated that ARPANSA is developing a guide for the drafting of a PSR that builds on IAEA safety guide *Periodic Safety Review for Nuclear Power Plants* and *Ageing Management for Research Reactors* (SSG-10). This was completed in the current reporting period and was published in April 2016 as ARPANSA *Regulatory Guide: Periodic Safety and Security Review for Research Reactors.*

[7] See http://www.arpansa.gov.au/Regulation/Branch/reviews.cfm and http://www.arpansa.gov.au/AboutUs/Collaboration/index.cfm

7. ARPANSA applies the Australian Government's "Trusted International Standards" (TIS) policy of 2015, under which Australian regulators should not impose requirements beyond those in trusted international standards unless there is a good reason to do so. In 2016, ARPANSA established a TIS register in its website listing all trusted international standards. These primarily comprise all relevant IAEA Safety Standards.

Article 8 –Regulatory body

8. In the past three years, the ARPANSA's Regulatory Services Branch's (RSB) staff numbers have decreased from 28 to 23 due to retirements and resignations. The shortfall is being made up through short-term contractual arrangements and by allocating resources to inspection and compliance monitoring using a graded, risk-informed approach. Work also commenced in 2016 for RSB to be compliant with the ISO 17020:2012 standard (on competence of inspection bodies).

9. In January 2015, the RSB introduced a new Delivery Model to improve regulatory effectiveness and efficiency, including increased use of risk-based oversight and risk-informed decision making. The Delivery Model describes how limited resources can be optimised whilst enhancing radiation and nuclear safety. It also details a rigorous approach to inspection.

Article 12 – Human factors

10. ARPANSA has published information and guidelines on holistic (or systemic) safety to provide guidance on key technological, human, and organisational aspects that are necessary to create and maintain optimal safety. Guidelines contain a range of key principles arranged under seven 'characteristics'. Within each 'characteristic' are 'attributes' that more specifically outline the ways in which the key principles of holistic safety can be achieved.

Article 14 – Assessment and verification of safety

11. Performance Objectives and Criteria (PO&C) have been developed by ARPANSA for use by inspectors. The PO&Cs reflect international best practices and are organised under eight 'baseline modules' and three cross cutting areas. The eight baseline modules cover performance reporting, configuration management, inspection, training, event protection, security, radiological protection, and emergency response/preparedness. The cross cutting areas are safety culture, human performance and performance improvement.

Article 16 – Emergency preparedness

12. Three major emergency exercises were conducted in the last three years at the Lucas Heights site where the OPAL reactor is located. All exercises involved external organisations and response teams. Two scenarios included evacuation of the reactor building (different triggers) and the treatment of contaminated or injured personnel. The third exercise was a site-wide evacuation that included the OPAL reactor. The exercises targeted effectiveness of the interfaces between ANSTO and external responders, adequacy of the processes at the OPAL reactor and site-wide protocols, and capabilities of personnel and equipment. The lessons learnt identified improvements in a number of areas, such as communications, coordination of responding teams, personnel decontamination process, and emergency management.

Article 18 – Design and construction

13. A significant change to the design of the OPAL reactor during the current reporting period was the addition of a Heavy Water Upgrade System to remove light water from the heavy water in the reflector vessel. Although the operation of the reactor was adapted to the modification, the safety effect was demonstrated to be minimal and fully within the safety design capabilities.

Article 19 - Operation

14. Recent changes to the OPAL operational limits and conditions include changes to increase the number of irradiated targets for the production of radiopharmaceuticals, the operation of the heavy water purification plant, and the application of a flexible fuel management strategy.

15. ANSTO's Reactor Operations Event Management System (ROEMS) was replaced with a more advanced event management system within the Governance Risk and Compliance (GRC) system. The system is used to manage and record all events, including abnormal occurrences, incidents and near misses. The system is also used to detail the investigations and analyses related to those events.

16. A siting and construction licence for the proposed ANSTO SyMo Facility was issued in 2014. This facility will be used for the solidification of intermediate level radioactive liquid wastes from molybdenum 99 production using ANSTO's patented SYNROC process. (The production of commercial quantities of radiopharmaceuticals is an activity that is closely related to the operation of the OPAL reactor.)

Article 6 – Existing Nuclear Installations

Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shutdown may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

Nuclear research reactor that existed at the time the Convention entered into force for Australia

6.1. The only research reactor at the time of entry into force of the Convention was the High Flux Australian Reactor (HIFAR) - a 10 MW(t) heavy water, tank type, materials testing reactor.[8] This reactor operated between 1958 and 2007. HIFAR has been shut down and all fuel has been removed. ANSTO is currently managing HIFAR under a 'possess or control' licence, while preparing to decommission it in future. ANSTO is expected to apply for a decommissioning licence once arrangements for the planned NRWMF are finalised.

List of current research reactors

6.2. Australia has one operating research reactor, the Open Pool Australian Light-water (OPAL) reactor.[9] OPAL is a high flux, thermal, multi-purpose pool type reactor. OPAL achieved full power of 20 Megawatts in 2006. The reactor is fuelled with low enriched uranium (LEU). The fuel elements are aluminium-clad uranium silicide plates. It is cooled by light water and has a heavy water reflector surrounding the core.

6.3. OPAL is housed in a containment building, which also includes the primary cooling circuit and most of the auxiliary plant. The stainless steel reactor pool has a water depth of 12.6 metres and is surrounded by thick-walled, reinforced high density concrete construction. The reactor core sits at the bottom of the pool and is surrounded by a Zircaloy reflector vessel which also houses all the irradiation rigs and beam tube assemblies. A service pool, contiguous with the reactor pool, stores the irradiated materials and provides for the interim storage of irradiated fuel. A reactor beam hall within the reactor building and a neutron guide hall adjacent to the reactor building contain experimental stations and instrumentation for neutron beam research purposes.

6.4. Other activities related to the operation of OPAL include the handling and storage of new and irradiated nuclear fuel and nuclear materials and the production of commercial quantities of radiopharmaceuticals and radioisotopes for use in medicine and research within Australia and overseas.

Overview of significant safety related issues in the last three years

6.5. There was no significant safety related issue in the past three years associated with the OPAL reactor.

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[8] Detailed specifications of HIFAR were provided in Annex 1 to the 2004 national report. (see http://www.arpansa.gov.au/pubs/regulatory/conventions/cns_rpt2.pdf). See also http://www.ansto.gov.au/AboutANSTO/HistoryatANSTO/HIFAR/index.htm

[9] See http://www.ansto.gov.au/AboutANSTO/OPAL/index.htm

Overview of planned programs and measures for continued safety

6.6. ARPANSA continues to conduct inspections on the OPAL reactor on a quarterly basis to monitor ongoing compliance with the Regulations and licence conditions. Additional requirements for ongoing periodic safety and security reviews (PSSR) have been stipulated in the revised licence issued in March 2015.

Challenges identified in the Sixth Review Meeting – Challenge 1 - Steps to minimise gaps between contracting parties' safety improvements.

6.7. ANSTO has, since 2006, taken part in a collaboration agreement with operators of the SAFARI-1 reactor (South Africa) and High Flux Reactor (HFR - The Netherlands). The aim is to work together to increase safety and reliability through cooperation as OPAL, SAFARI-1 and HFR are similar reactors. Meetings are held every 12 to 18 months to exchange ideas, experiences and good practices.

6.8. ARPANSA has working relationships with a number of overseas regulators, including with the US Nuclear Regulatory Commission (NRC) to exchange information and lessons learnt. Overseas consultants are also engaged on short term projects to learn from and adapt good regulatory practices from international counterparts. At the time of writing of this report, a senior manager from the US NRC is a member of a panel that is assisting ARPANSA to undertake a self-assessment of its regulatory practices. This self-assessment is a requirement of the Australian Government under the Regulator Performance Framework that requires regulators to undertake annual self-assessment of their effectiveness and efficiency.[10]

[10] See http://www.arpansa.gov.au/Regulation/goodregulatorypractice/index.cfm

Article 7 – Legislative and Regulatory Framework

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.

Australian Radiation Protection and Nuclear Safety Act 1998 (the Act)

7.1. The Act applies only to Australian Government entities and their contractors. It enables the regulatory framework to govern the safety of, among others, OPAL and HIFAR. The Act was amended in 2015 to provide the CEO with additional powers to direct a licence holder, issue improvement notices, and compel the provision of information.

2. The legislative and regulatory framework shall provide for:

(i) the establishment of applicable national safety requirements and regulations;

The Australian Radiation Protection and Nuclear Safety Regulations 1999 and other regulatory guidance documents

7.2. The Australian Radiation Protection and Nuclear Safety Regulations 1999 (the Regulations) set up a framework for licensing, inspection and enforcement. The Regulations also contain licence conditions and specify dose limits. ARPANSA also publishes regulatory guidelines to guide licence applicants and licence holders. Relevant guidelines include guides to prepare licence applications, *Regulatory Assessment Principles* and other activity specific guides. These guidance documents are published on ARPANSA's Internet website[11]. ANSTO is consulted during the development or amendment of regulatory guides applicable to OPAL and HIFAR.

7.3. The last national report stated that ARPANSA is developing a guide for the drafting of a PSR that builds on IAEA safety guide *Periodic Safety Review for Nuclear Power Plants* and *Ageing Management for Research Reactors* (SSG-10). This was completed in the current reporting period and was published in April 2016 as ARPANSA *Regulatory Guide: Periodic Safety and Security Review for Research Reactors*.[12]

7.4. ARPANSA also applies the Australian Government's "Trusted International Standards" (TIS) policy of 2015, under which Australian regulators should not impose requirements beyond those in trusted international standards unless there is a good reason to do so. In 2016, ARPANSA established a TIS register in its website listing all trusted international standards. These primarily comprise all relevant IAEA Safety Standards. (***This is an example of how ARPANSA implements Principle 3 of the Vienna Declaration on the application of IAEA Safety Standards***)

(ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence:

Licensing

7.5. The Act prohibits the siting, construction, operation, possession and control, or decommissioning of nuclear installations by a Commonwealth entity without a licence issued by ARPANSA. Applicants for a licence are required to submit, among others, 'plans and arrangements' to demonstrate how the applicant will maintain effective control, manage safety and security, and protect the environment. Licences may contain conditions that the licence holder must comply with.

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11 www.arpansa.gov.au/Regulation/guides.cfm;

12 http://www.arpansa.gov.au/pubs/regulatory/guides/REG-COM-SUP-270I.pdf

(iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences;

Inspections

7.6. The Act provides powers of entry for inspectors to enter OPAL and inspect it at reasonable times. Inspectors are authorised to undertake searches and exercise a range of powers. An *Inspection Manual* is available to guide inspectors on the exercise of their powers. ARPANSA has developed a risk-based approach to its inspection program, which is designed to emphasise its safety assurance role.

7.7. A baseline inspection program defines the minimum level of planned inspections to evaluate performance over a three-year period. The program aims to monitor all facilities to provide assurance that performance of the licence holder meets safety and security objectives. There are eight inspection areas. Each of these areas must be inspected at least once during the baseline period. Although the approach will be the same, the specifics will vary and each facility will have to be looked at individually. The nature and scope of inspections is tailored to the facility.

(iv) the enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.

Enforcement

7.8. The Act provides enforcement measures, which include cancellation or suspension of a licence, modification of a licence, issuing directions to a licensee, varying licence conditions, imposing additional licence conditions, or prosecution. However, inspectors also have discretion to respond appropriately with a graded approach as described below:

- *Informal management of performance deficiencies*: Where a 'performance deficiency' is identified, the licence holder is expected to take remedial actions. ARPANSA will follow-up to check progress.
- *Finding of breach*: A finding of breach will only be made by the CEO (or his delegate). In many cases, the CEO must first determine if the licence holder has taken all reasonably practicable steps to prevent a breach.
- *Enforcement actions:* The CEO has full discretion and enforcement action will be taken only if it is absolutely necessary for safety outcomes. ANSTO has previously been found in breach in respect of OPAL and HIFAR, but the breaches were rectified and no formal enforcement action (e.g., prosecution) was necessary.

Article 8 – Regulatory Body

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.

ARPANSA

8.1. The Act establishes the office of the CEO of ARPANSA. The CEO has both regulatory and non-regulatory functions. The non-regulatory functions include promoting national uniformity in radiation protection policy and processes among States and Territories, providing scientific advice, providing radiation monitoring and calibration services, and undertaking research.

8.2. The Regulatory Services Branch (RSB) assists the CEO to perform his regulatory functions. The RSB has primary[13] responsibility for regulating the safety and security of OPAL and HIFAR. In addition to licensing, compliance monitoring and enforcement, the RSB also investigates accidents and incidents and prepares regulatory guidance material. The RSB's regulatory functions also include other facilities such as radioisotope production facilities, radioactive waste management facilities, accelerators, and irradiators.[14]

Human resources and competencies

8.3. In the past three years, the RSB's staff numbers have decreased from 28 to 23, due to retirements and resignations. The shortfall is being made up through short-term contractual arrangements and by allocating resources to inspection and compliance monitoring using a graded, risk-informed approach. The costs of RSB's operations are recovered from licence applications fees and annual licence charges.

8.4. RSB staff's competence has been maintained through targeted training. This is done through annual formal training as well as on-the-job training and supervision. Staff have also undergone ongoing professional development through participation in international meetings, workshops and technical consultancies.

8.5. CEO ARPANSA can also for specific purposes draw on expertise from other Branches of ARPANSA and is also supported by the Corporate and Legal Offices, and by the Office of the CEO. ARPANSA's overall staffing level at the time of submission of this report was just over 130 full-time equivalents.

Statement of adequacy of resources

8.6. Although the RSB's full-time staffing level has decreased in the last three years, the shortfall is being managed by allocating resources to inspection and compliance monitoring using a graded, risk-informed approach. In January 2015, the RSB introduced a new Delivery Model to improve effectiveness and efficiency. The Delivery Model describes how limited resources can be optimised. It also details a rigorous approach to inspection.[15]

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[13] The Australian Safeguards and Non-Proliferation Office has responsibility for all safeguards and non-proliferation matters in relation to the nuclear material at ANSTO.

[14] For further information see http://www.arpansa.gov.au/Regulation/Applicants/index.cfm

[15] See http://www.arpansa.gov.au/Regulation/goodregulatorypractice/index.cfm

Quality management

8.7. ARPANSA has a Quality Management System (QMS) to develop and maintain policies, procedures, forms and guides of a regulatory nature. The QMS provides assurance to stakeholders that regulatory processes are open and accountable and services are provided in an effective and efficient manner and subject to continuous improvement. The QMS meets the requirements of AS/NZS ISO 9001 standard. In 2016, RSB started working towards compliance with ISO 17020:2012 standard (on competence of inspection bodies).

Advisory committees

8.8. CEO ARPANSA receives advice on radiation protection and nuclear regulatory matters from three statutory committees. These are the Radiation Health and Safety Advisory Council, the Nuclear Safety Committee and the Radiation Health Committee.

8.9. The Radiation Health and Safety Advisory Council has the following functions:

- to identify emerging issues relating to radiation protection and nuclear safety and to advise the CEO on them;
- to examine matters of major concern to the community in relation to radiation protection and nuclear safety and to advise the CEO on them;
- to advise the CEO on the adoption of recommendations, policies, codes and standards in relation to radiation protection and nuclear safety;
- to advise the CEO, at the CEO's request, on other matters relating to radiation protection and nuclear safety;
- to advise the CEO on such other matters relating to radiation protection and nuclear safety as the Council considers appropriate;
- to report to the CEO on matters relating to radiation protection and nuclear safety.

8.10. The Nuclear Safety Committee has the following functions:

- to advise the CEO and the Council on matters relating to nuclear safety and the safety of controlled facilities;
- to review and assess the effectiveness of standards, codes, practices and procedures in relation to the safety of controlled facilities;
- to develop detailed policies and to prepare draft publications for the promotion of uniform national standards in relation to the safety of controlled facilities;
- to report to the CEO on matters relating to nuclear safety and the safety of controlled facilities.

8.11. The Radiation Health Committee has the following functions:

- to advise the CEO and the Council on matters relating to radiation protection;
- to develop policies and to prepare draft publications for the promotion of uniform national standards of radiation protection;
- to formulate draft national policies, codes and standards in relation to radiation protection for consideration by the Commonwealth, the States and the Territories;
- to review national policies, codes and standards in relation to radiation protection to ensure that they continue to substantially reflect world best practice;
- to consult publicly in the development and review of policies, codes and standards in relation to radiation protection.

2. Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organisation concerned with the promotion or utilisation of nuclear energy.

8.12. Although ARPANSA and ANSTO are Government entities, ARPANSA is within the Health portfolio, while ANSTO is a Government-owned business within the Industry, Innovation and Science portfolio. Besides this structural separation, ARPANSA's independence is further assured through requirements in the Act. These include:

- A requirement to report quarterly and annually to Parliament on the operations of ARPANSA and any finding of breach of licence condition or legislation;
- A requirement to report to Parliament about any serious accident or malfunction that occurs at a nuclear installation, including the OPAL and HIFAR reactors;
- A requirement for the Minister to table in Parliament any direction that he or she makes to the CEO of ARPANSA

Challenges identified in the Sixth Review Meeting – Challenge 4 – regulatory independence, safety culture, transparency and openness

Independence

8.13. The CEO of ARPANSA is required by the Act to avoid any conflict of interest between his regulatory function and other functions (e.g., dose monitoring and calibration). This is achieved by ensuring that regulatory functions, (licensing, inspections, compliance management, and enforcement) are performed by the Regulatory Services Branch (RSB), with staff mainly located in Sydney. In addition, the CEO ensures that any regulatory function exercised over other parts of ARPANSA is independently overseen by external personnel. Annual training is also conducted for all regulatory officers on managing conflicts of interest.

Openness and transparency

8.14. The RSB's regulatory processes are fully transparent. The regulatory assessment reports that form the basis for licensing decisions are published on the Internet and are available for public scrutiny. The CEO also publishes his statement of reasons for all licence decision in relation to nuclear installations. Inspection reports and findings of breach are also published on the Internet. The Act makes it mandatory for the CEO of ARPANSA to report on his operations, including findings of breach and non-compliance, to Parliament every quarter and annually.

Safety culture

8.15. ARPANSA places a very strong emphasis on safety culture. "Safety culture" is one of the three 'cross-cutting' areas in the performance criteria that inspectors' use. For a more detailed discussion on safety culture and holistic (systemic) safety, see Article 10 below.

Article 9 – Responsibility of the Licence Holder

Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

9.1. The Regulations places prime responsibility for safety on the licence holder. This is primarily done through Regulation 49, which provides as follows:

> *49 Managing safety*
>
> *(1) The holder of a facility licence must take all reasonably practicable steps to manage the safety of the facility, including:*
>
> *(a) having in place plans and arrangements of the kind mentioned in item 4 of the table in clause 1 of Schedule 3; and*
>
> *(b) ensuring that such plans and arrangements are implemented to the extent reasonably practicable.*

9.2. Other provisions in the Act and Regulations reinforce the fact that primary responsibility for safety rests with the licence holder. These include requirements on the licence holder to proactively investigate and rectify any breaches, prevent, control and minimise accidents, and report accidents to ARPANSA within 24 hours.

9.3. ANSTO's responsibility for safety is defined in its Work Health, Safety and Environment (WHSE) Policy and the supporting safety management system which is certified to ISO 9001 and 14001 standards. This system establishes responsibilities for health, safety and environmental protection. To support the safety management system, ANSTO has safety assessment, approval and audit systems overseen by internal committees that are independent of line management responsible for OPAL operation. The overarching safety body, the Safety Assurance Committee (SAC), has external membership to ensure independent oversight.

9.4. As part of the application for a Facility Licence Operating Authorisation for OPAL, ANSTO submitted a suite of safety related documentation which includes how appropriate effective control is maintained (resourcing, technical expertise etc.) and emergency response is handled. This suite of safety documents is reviewed as part of the ongoing inspection programme. Any proposal to change ANSTO's arrangements for managing safety that has significant implications for safety requires ARPANSA's prior approval.

9.5. ARPANSA Inspectors regularly monitor and review the operations of ANSTO's nuclear operations. The inspectors undertake planned inspections of the nuclear facilities and frequent site visits. Inspectors use these opportunities to emphasise and stress the licence holder's primary responsibility for safety.

Article 10 – Priority to Safety

Each Contracting Party shall take the appropriate steps to ensure that all organisations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety

10.1. ARPANSA's requires applicants for a licence and licence holders to demonstrate a commitment to a strong safety culture. The *Regulatory Guide: Plans and Arrangements for Managing Safety*[16], against which licence applications are assessed, states:

> *The Licence Holder or Applicant is responsible for establishing safety as the organisation's highest priority, consistent with international best practice in radiation protection and nuclear safety and overriding, if necessary, the demands of production or project schedules.*

10.2. The plans and arrangements are required to provide sufficient details on how the applicant will exercise effective control and manage safety, including measures to foster a safety culture. Specific plans are required to be submitted on how the applicant will monitor and self-assess safety, including undertaking independent safety assessments for radiation protection, radioactive waste management, security and emergency preparedness.

10.3. Once a licence is issued, the Regulations require the licence holder to take all reasonably practicable measures to manage safety. Specifically, the licence holder must continue to have in place plans and arrangements that are reviewed and updated at least once every three years. The licence holder must also take all reasonably practicable measures to implement the plans and arrangements. Non-compliance with these requirements may be a breach of licence condition.

ANSTO's safety policies

10.4. As part of its business management system, ANSTO has a WHSE policy, under which it undertakes its activities in a manner that places the protection of human health and safety and the environment as its highest priority, promotes a positive safety culture and environmental awareness; and strives for continual improvement in safe work practices using a blame-free learning approach. In addition to the WHSE policy, ANSTO also supports a positive safety culture through risk management and quality management policies and systems.

ANSTO safety management and culture

10.5. ANSTO implements its safety policy and strategies through a work health and management system that covers radiological, nuclear and occupational health and safety. The system makes every member of ANSTO's staff responsible for ensuring compliance with the organisation's work health, safety and environment policy and strategies, and line management accountable for safety.

10.6. Safety assurance at ANSTO is achieved by several mechanisms. Changes at the OPAL reactor that have any impact on nuclear safety are reviewed by the Reactor Assessment Committee (RAC). Additional assurance of safety is achieved through routine inspections by staff, who are independent of the function being assessed, and the review of safety performance by senior management and the ANSTO Board. In

[16] See http://www.arpansa.gov.au/Regulation/guides.cfm

undertaking its assessments, the RAC has regard to applicable IAEA Safety Standards. (***This is an example of how ANSTO implements Principle 3 of the Vienna Declaration on the application of IAEA Safety Standards*****)**

Safety Performance Indicators

10.7. ANSTO has, in consultation with ARPANSA established Safety Performance Indicators (SPIs) for OPAL. These SPIs measure and set objective targets for 22 safety related functions of plant operation and organisational performance and are divided into four groups:

- Reactor safety (e.g. unplanned reactor trips);
- Radiation safety (e.g. maximum individual effective dose);
- Industrial safety (e.g. lost time injuries); and
- Safety management (e.g. number of accredited operators).

Performance against the SPIs is reported quarterly to ARPANSA and monthly within ANSTO.

Article 11 – Financial and Human Resources

1. Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.

Financial Resources

11.1. In making a licence decision, the CEO of ARPANSA must consider whether the applicant has shown a capacity to comply with the Regulations and any licence condition that may be imposed. This includes an assessment of the financial capacity of the licence holder. ANSTO must provide evidence of adequate resources, including financial capability, before it is issued with an operating licence.

11.2. The bulk of ANSTO's operating revenue is provided by the Australian Government. ANSTO also generates revenue from the sale of goods and services, particularly radiopharmaceuticals. ANSTO has demonstrated to ARPANSA's satisfaction that it has adequate financial capability to support the safety of OPAL and HIFAR, including in the event of an emergency.

2. Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.

Human resources - ARPANSA

11.3. The Regulatory Services Branch's Facility Licensing Section is primarily responsible for the compliance and inspection program for safety related aspects of the operation of OPAL. A dedicated lead inspector for OPAL is supported by another 4 staff who assist the lead inspector.

11.4. Regulatory staff must complete on the job training in relevant technical areas before being eligible to be appointed as an inspector. In addition, inspectors must have either obtained or be working towards a nationally recognised accreditation, namely, Certificate IV in Government. Competencies that this program offers are the ability to exercise regulatory powers, promote and assess compliance with legislation, investigate non-compliance, conduct and record interviews, conduct a search and possible seizure and prepare evidence. Additional annual training is conducted for all regulatory staff in inspection reporting, conflict of interest and legal awareness.

Human resources - ANSTO

11.5. ARPANSA requires ANSTO to demonstrate adequate managerial structure and resources to ensure positive safety attitudes and high standards of human performance and competence. This includes demonstrating clear lines of authority as well as systems for staff selection, training, and personnel stability.

11.6. OPAL is operated with a rotating roster of at least two Reactor Operators and a Shift Manager. Shift Managers have, as a minimum, an appropriate university degree, often in engineering or physics. Reactor Operators and Shift Managers undergo a period of intensive training at the start of their employment and are required to demonstrate competence in reactor operation and safety through an accreditation process. Reactor Operators and Shift Managers are re-accredited every three years.

11.7. In addition to Reactor Operators and Shift Managers, OPAL has significant human resources in utilisation, engineering and maintenance, nuclear analysis and technical support under the management of the General Manager of Nuclear Operations.

11.8. The arrangements for qualification training, accreditation and retraining of OPAL staff are summarised in the OPAL Safety Analysis Report[17]. OPAL reactor training is designed to provide personnel with the knowledge and skills needed to perform their roles, a healthy respect for nuclear safety and radiation protection issues, and an awareness of the impact that actions have on safety and performance. The three components of training at the OPAL reactor are induction, role-specific, and ongoing training.

11.9. The implementation of the arrangements is detailed in various procedures, instructions and manuals that are part of the Nuclear Operations Business Management System, which is ISO9001 and ISO14001 certified as part of the overall ANSTO Business Management System (ABMS).

11.10. OPAL operations are supported by staff from other parts of ANSTO who provide services in radiation protection, waste management and engineering as well as finance and procurement, site services, human resources and general administration as required. These services are stipulated by a series of Service Level Agreements (SLAs) between OPAL and the respective division providing the service. The SLAs stipulate the nature, frequency and standard of the services provided.

11.11. ARPANSA's inspections on OPAL include training. ARPANSA inspectors are invited to observe shift operator and manager accreditation panels to ensure that the process is robust.

[17] See http://www.arpansa.gov.au/Regulation/opal/op_applic.cfm.

Article 12 – Human Factors

Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

12.1. ARPANSA's human factors requirements are detailed in the *Regulatory Assessment Principles* and the *Regulatory Assessment Criteria for the Design of New and Modification of Existing Controlled Facilities*. Systems and procedures must be designed with systemic consideration of human factors at the individual and organisational levels to reduce the potential for human error and violations, facilitate correct actions by operators, and reduce operator stress. Human factors must also be taken into account in any probabilistic safety assessment.

12.2. ARPANSA has also developed a set of *Holistic Safety Guidelines*[18] to provide guidance on key technological, human, and organisational aspects that are necessary to create and maintain optimal safety. Guidelines contain a range of key principles considered relevant to holistic (or systemic) safety. The key principles of holistic safety are arranged under seven 'characteristics'. Within each 'characteristic' are 'attributes' that more specifically outline the ways in which the key principles of holistic safety can be achieved.

12.3. The seven characteristics are human aspects, non-technical skills, defence-in-depth, management system, resilience, safety culture, and security. Human factors are covered in every inspection of the OPAL reactor

OPAL

12.4. OPAL has had a dynamic Human Factors (HF) Program from its inception that will continue to evolve until the reactor is decommissioned. The program aims to optimise the human-machine interface to avoid operational/maintenance errors and violations. The HF design plans for OPAL were proposed by ANSTO and reviewed by ARPANSA. The HF commitments are defined in various sections of the OPAL Safety Assessment Report (SAR). All safety related events/incidents are reported and investigated following the Event Management and Event Response Process. This process also captures incidents and abnormal occurrences, suggestions for improvement, and includes human factor and organisational related issues.

12.5. ANSTO is required by the Regulations and a licence condition to analyse the causes of incidents (abnormal safety occurrences) and lessons learned. Since the last CNS report, there have been a number of nuclear safety related events, but nothing significant. In its Quarterly Report to ARPANSA, ANSTO provides a list of events or incidents which have occurred in the previous quarter. These incidents are reviewed and discussed by both organisations at a quarterly meeting.

[18] See http://www.arpansa.gov.au/Regulation/Holistic/index.cfm

Article 13 – Quality Assurance

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programs are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

13.1. ARPANSA's Regulatory Services Branch has a Quality Management System (QMS). The RSB is also working towards compliance with ISO 17020 Standard, which, when completed by end-2018, will seamlessly integrate with a planned agency-wide Integrated Management System certified to ISO 9001 standard.

13.2. Under the *Regulatory Assessment Principles*, ARPANSA assesses if a licence applicant has demonstrated steps that will be taken for quality assurance of its nuclear facilities, including how a formal QA program will be applied at each stage of the life of the reactor.

OPAL

13.3. The administrative control of OPAL is undertaken in accordance with the Nuclear Operations Business Management System (BMS). This system sits within the ANSTO Quality Policy and ANSTO Business Management System (ABMS) framework. The ABMS covers ANSTO policies, overarching processes and supporting guidance. The ABMS (and hence, the Nuclear Operations BMS) is ISO 9001 certified.

13.4. The lead document of the Nuclear Operations BMS is the *Nuclear Operations Business Management System Manual*, and below this lie the range of manuals, procedures, instructions, and forms for operational and maintenance activities. The documents include response to alarms and emergency operating instructions. ARPANSA reviewed these documents as part of the licence application assessment process and regularly undertakes inspections to determine if OPAL operation is consistent with the documentation contained in the Nuclear Operations BMS.

13.5. ANSTO undertakes regular internal management system audits in accordance with its ISO 9001 quality system and ISO 14001 environmental system certifications that verify activities are compliant with the Nuclear Operations BMS and to identify process improvements. ANSTO is also subject to regular surveillance and re-certification audits by an accredited external organisation in order to maintain its ISO 9001 quality system and ISO 14001 environmental management system certifications.

Article 14 – Assessment and Verification of Safety

Each Contracting Party shall take the appropriate steps to ensure that:

i. comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;

Safety Assessment Reports (SAR)

14.1. ARPANSA's licensing process is staged. A separate licence is required for each stage of a nuclear reactor's lifecycle from the preparation of a site to decommissioning. ARPANSA requires a preliminary SAR (PSAR) to be included in an application for a licence to construct a reactor. A final SAR (FSAR) is an updated version of the PSAR and must be submitted when applying for a licence to operate a reactor. The SAR is treated as a living document and is required to be updated throughout the life of the reactor.

14.2. The SAR must include deterministic safety analyses to determine if the safety limits and objectives will be met for design-basis accidents. A probabilistic safety assessment may supplement the deterministic safety assessment of design-basis and beyond-design-basis accidents. The operating limits and conditions (OLC) are determined from the safety analyses

14.3. ARPANSA's requirements for each phase of a nuclear reactor's lifecycle can be summarised as follows:

Siting	Detailed site evaluation, including a consideration of the extent to which the site may be affected by natural and man-made events, and environmental impact assessments
Construction and operation	Design information, including the OLC within which the reactor must operate, the safety analysis, and detailed plans and arrangements for safety.
Possession and control	Arrangements for safe storage of radioactive material and maintaining the nuclear reactor.
Decommissioning and abandoning	Decommissioning plans and results (respectively) and the details of any proposed environmental monitoring program for the site.

OPAL

14.4. ARPANSA issued the operating licence to OPAL in 2006 following a detailed assessment of the SAR submitted by ANSTO. Any change to the SAR with significant implications for safety requires approval before implementation.

14.5. ANSTO has a well-developed and sophisticated system for safety assessment and verification, including the requirement for prior review and approvals of modifications to all licensed facilities that have the potential for significant implications for safety. Changes at the OPAL reactor that have any impact on nuclear safety must be reviewed by the Reactor Assessment Committee (RAC).

ii. verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

Safety verification

14.6. The Regulations require a licence holder to take all reasonably practicable measures to implement its plans and arrangements for managing safety. The licence holder is also required to review those plans and arrangements at least once every three years. Any change to plans and arrangements that may have significant implications for safety must be approved prior to implementation.

14.7. ARPANSA conducts planned inspections to verify the safety of OPAL and HIFAR. The inspections aim to assess the safety performance of ANSTO and provide reasonable assurance to the Australian Government and the public that activities involving radiation facilities and sources do not pose a threat to human health or the environment. The inspections focus on compliance with the Act and Regulations. A set of Performance Objectives and Criteria (PO&C)[19] are used by inspectors for a transparent and graded approach to assess licence holders' practices and is consistent with the risk of the facility.

14.8. The PO&Cs reflect international best practices and are organised under eight 'baseline modules' and three cross cutting areas. One or more of these modules is used for the inspection of facilities. The eight baseline modules cover:

- performance reporting,
- configuration management,
- inspection, testing and maintenance,
- training
- event protection
- security
- radiological protection
- emergency response and preparedness

14.9. The cross cutting areas are safety culture, human performance and performance improvement.

14.10. ARPANSA also undertakes routine site visits to OPAL and HIFAR. Site visits supplement the inspection program and are regular, frequent and informal visits to the premises of a licence holder for regulatory oversight and discussions.

Periodic Safety Review

14.11. The OPAL operating licence requires ANSTO to undertake periodic safety reviews (PSR). The first PSR report was submitted to ARPANSA in December 2011 and a further supplementary PSR report was submitted in June 2013. ARPANSA reviewed and accepted the PSR in October 2014. The reviews identified a high degree of conformity by ANSTO with the current international safety standards and practices. The licensing basis was found to be valid.

[19] See http://www.arpansa.gov.au/Regulation/inspections/POandC.cfm

Article 15 – Radiation Protection

Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

15.1. The Regulations require ARPANSA to be satisfied that licence holders optimise radiation protection. The Regulations also set out statutory effective dose limits. ARPANSA monitors whether ANSTO ensures that radiation doses arising from normal operation and anticipated operational occurrences throughout the life of the reactor are optimised and do not exceed the dose limits.

OPAL Reactor

15.2. ANSTO's plans and arrangements for OPAL include a Radiation Protection Plan, which covers the following:

- roles and responsibilities for radiation protection;
- an evaluation and safety assessment of the main radiological hazards in OPAL;
- access control to areas with radiological hazards;
- administrative controls for management of radiological hazards;
- radiological monitoring programs for plant, individuals and the environment;
- transportation of radioactive materials;
- training requirements for radiation protection; and
- arrangements for reviewing the radiation protection plan.

15.3. Radiation protection in OPAL is managed with advice from a dedicated Radiation Protection Adviser (RPA). The RPA is supported by a group of radiation protection personnel working in OPAL, including health physics surveyors. The RPA advises on the continuing effectiveness of controls against identified radiological hazards within OPAL and co-ordinates radiation monitoring programs.

15.4. Doses associated with OPAL are typically low, due to design features which limit operational exposure. These features include a reactor pool incorporating a hot water layer, which reduces ambient dose-rates associated with activation and contamination products. Other features include dedicated hot cells for handling irradiated materials, and demarcating areas of restricted access during reactor operation.

Article 16 – Emergency Preparedness

1. Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency. For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.

16.1. The Regulations require a licence applicant to include its emergency plans in its submissions that support a licence application. The Regulations also require the plans and arrangements to be reviewed at least once every three years. Under the *Regulatory Guideline on the Review of Plans and Arrangements,* ARPANSA expects emergency plans to be in place for any action that could give rise to a need for emergency intervention and be based on an assessment of the consequences of reasonably foreseeable accidents, including those with off-site consequences.

16.2. Emergency plans must also aim to minimise consequences and ensure protection of on-site personnel, the public and the environment; have comprehensive procedures, and require all external organisations identified in the emergency plan to be prepared for emergencies with adequate and well-maintained facilities and equipment.

OPAL

16.3. ANSTO has an Emergency Response Plan for its entire site, which is integrated with the emergency plans of the State of New South Wales. There is a sub-plan covering a major incident at ANSTO which may involve local evacuations. An emergency plan exists for the OPAL, with the requirement for a major exercise every two years and more frequent drills on particular aspects of the plan. Major exercises have been held regularly in accordance with the plan. These exercises were witnessed by ARPANSA inspectors. In addition, desktop drills are performed once a week by the duty shift, such that every shift completes a drill once every four to six weeks.

16.4. The implementation of these emergency plans for the ANSTO site is regularly discussed with emergency response agencies, local council and others at the ANSTO Local Liaison Working Party, in which ARPANSA is an observer. The plans are also available in local public libraries.

16.5. The OPAL reactor conducted three major emergency exercises in the last three years. All exercises involved external organisations and response teams. Two scenarios included evacuation of the reactor building (different triggers) and the treatment of contaminated or injured personnel. The third exercise was a site-wide evacuation that included OPAL reactor. The exercises targeted effectiveness of the interfaces between ANSTO and external responders, adequacy of the processes at the OPAL reactor and site-wide protocols, and capabilities of personnel and equipment. The lessons learnt identified improvements in a number of areas, such as communications, coordination of responding teams, personnel decontamination process, and emergency management.

16.6. Assessments of the radiological consequences of acts of sabotage and terrorism in relation to OPAL have been undertaken by ANSTO and reviewed by ARPANSA. It has been concluded that the current emergency plans and arrangements, including adoption of the World Health Organisation (WHO) guidelines for the dissemination of iodine tablets, provide adequate protection of the public for such events.

2 Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.

16.7. The Emergency Operations Centre communications systems that would be set up in the event of a major emergency have enough channels to deal with internal and external links. This includes communication to external authorities and the public. In the event of a nuclear or radiological accident, information will be provided to Emergency Management Australia, which will continuously monitor the situation and inform stakeholders, including the public, of important updates, in accordance with the Regional Disaster Plan.

16.8. The geographical location of Australia means that an emergency in OPAL will not affect the population of neighbouring countries. Australia is a Party to the *Convention on the Early Notification of a Nuclear Accident* and the *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency*. ARPANSA is the designated National Competent Authority for these Conventions, and the Australian Crisis Coordination Centre, located in the Attorney General's Department, is the designated National Warning Point.

3. Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.

16.9. Australia is not geographically close to any State operating a nuclear installation. Nevertheless, Australia has appropriate precautions in place in relation to radiation emergencies in other countries, including the provision of information to the public and decision makers and the monitoring of imported foodstuffs. For example, during the Fukushima nuclear emergency, ARPANSA provided round the clock technical advice to the Australian Government. Using weather prediction data, ARPANSA modelled the movement of airborne radioactive plumes, both potential and real, on a daily basis to ensure that Australians were given adequate advice while in Japan. ARPANSA also worked with Australia's food standards regulator to assess the available information on contamination levels in water, milk and foodstuffs in Japan and to screen foodstuffs from Japan and made the information available publicly.

Lessons learnt from the Fukushima Daiichi accident

16.10. A preliminary assessment of the implications of the accident for the OPAL reactor identified minor areas for improvement. These were reported after the first Periodic Safety Review between December 2011 and June 2013. An example is the installation of a quick connector to provide emergency water supply to the OPAL reactor.

16.11. ANSTO has since undertaken a formal safety reassessment in accordance with IAEA Safety Report Series No. 80, *Safety Reassessment for Research Reactors in the light of the accident at the Fukushima Daiichi Nuclear Power Plant*. A number of recommendations were made, none of which require immediate corrective action but are opportunities for improvement. Examples include extension of the existing design basis and beyond design basis accident analyses in the Safety Analysis Report to explicitly consider combinations of events and to improve emergency response and management. ANSTO has also reviewed its Emergency Operating Instructions to ensure they cover the additional fault scenarios identified.

Article 17 – Siting

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

i. for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;

ii. for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;

iii. for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;

17.1. In addition to the general requirements for licensing (see Article 7), the Regulations provide that an application for a siting licence must also contain:

- A detailed site evaluation establishing the suitability of the site;
- The characteristic of the site, including the extent to which the site may be affected by natural and man-made events; and
- Any environmental impact statement prepared for the site.[20]

17.2. The regulatory guide, *Siting of Controlled Facilities*, provides detailed guidance on meeting the requirement of the Regulations. ARPANSA's *Regulatory Assessment Principles* set the expectation that the design of a facility should take into account:

- The site's seismology, geology, topography, demography, ecology, hydrology, and meteorology.
- The effect of nearby facilities and land usage.
- The availability and reliability of off-site services such as electricity, water, transportation, and communication systems.
- The feasibility of emergency response.

OPAL

17.3. The ANSTO site was authorised for the construction of OPAL only after ANSTO demonstrated to ARPANSA's satisfaction[21] that the site is suitable for the construction and operation of a reactor, while providing adequate protection of the health and safety of people and the environment. ANSTO demonstrated that:

- the site provides acceptable radiological protection during normal operation and in the event of severe accidents, through the evaluation of a Reference Accident; and
- the natural characteristics of the site and man-induced phenomena can be accommodated safely in the design bases of the reactor.

[20] The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* contains provisions forbidding Commonwealth agencies from undertaking "nuclear actions" which might have a significant impact upon the environment without the consent of the Minister for the Environment, who may require the preparation of an environmental impact statement before approval is granted.

[21] See http://www.arpansa.gov.au/Regulation/opal/siting.cfm for an outline of the site licensing process and significant documents.

iv. for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

17.4. Due to Australia's geographical location and the low power level of the OPAL reactor, its operation could not affect any other Contracting Parties. As stated above, Australia is a Party to the *Convention on the Early Notification of a Nuclear Accident* and the *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency*.

17.5. The Lucas Heights site was reassessed in 2013 as part of the OPAL Periodic Safety Review. The site was also reassessed when ANSTO applied for a licence to construct an Interim Waste Store (IWS) to house reprocessed waste products from HIFAR operations. An application to prepare a site for the IWS was received in early 2013, and was approved in November 2013 following assessment by ARPANSA against its siting requirements, including the latest IAEA requirements for siting nuclear installations.

Article 18 – Design and Construction

Each Contracting Party shall take the appropriate steps to ensure that:

i. the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defence in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

ii. the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

iii. the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

18.1. ARPANSA's *Regulatory Assessment Principles* and *Regulatory Assessment Criteria for the Design of New Facilities* are structured to reflect internationally accepted principles of defence in depth. The *Principles* state the need for proven engineering practice and standards in the siting, design, manufacture, construction, installation, and commissioning of a reactor. The *Principles* also set the following expectations for human factors at the design stage:

- facilities are designed with systematic consideration of human factors and ergonomic principles to reduce the potential for human error, facilitate correct actions by operators, and reduce operator stress
- safety systems at nuclear reactors are designed to be automatically initiated and to require no immediate operator action within 30 minutes, while permitting operator initiation or action where necessary to ensure or enhance safety
- control and control room layout provides ergonomic disposition of data and controls for actions important to safety, including accident management
- diagnostic aids are provided to speedily resolve questions important to safety and to monitor the status of the reactor
- reliable and redundant communications systems are provided for all operations staff
- maintenance and inspection aspects such as access are considered in the design of equipment and systems.

OPAL

18.2. The factual compliance of OPAL with Article 18 was discussed in detail in Australia's 2007 national report[22]. A significant change to design during the current reporting period was the addition of a Heavy Water Upgrade System to remove light water from the heavy water in the reflector vessel**.** Although the operation of the reactor was adapted to the modification, the safety effect was demonstrated to be minimal and fully within the safety design capabilities.

Vienna Declaration on Nuclear Safety – Principle 1

18.3. The siting, design and construction of OPAL took into account the elements covered by Principle 1 of the Vienna Declaration, namely, the prevention of accidents during the commissioning and operations phase.

[22] See http://www.arpansa.gov.au/AboutUs/Collaboration/nucsafety.cfm

Article 19 – Operation

Each Contracting Party shall take the appropriate steps to ensure that:

i. the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

19.1. The ARPANSA licensing process requires the applicant to furnish specific information when applying for a licence to operate a nuclear research reactor. These include:

- Arrangements for maintaining criticality safety during loading, moving or storing nuclear fuel and other fissile materials.
- A description of the structures, components, systems and equipment of the reactor as they have been constructed.
- A Final Safety Analysis Report that demonstrates the adequacy of the design, the operating limits and conditions, and arrangements for commissioning and operations.

19.2. In assessing a licence application for a nuclear research reactor, ARPANSA must, under the Act, take into account international best practice in radiation protection and nuclear safety. The relevant international best practice documents comprising primarily IAEA Safety Standards are listed on the ARPANSA website[23]. A description of the licence approval process and the authorisation issued to ANSTO to operate OPAL was reported in the Australian national report in September 2007.[24]

ii. operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

19.3. The Regulations require an applicant for an operating licence to specify the operational limits and conditions (OLC). Failure to comply with an OLC may be a breach of a condition of licence. ARPANSA continues to monitor that OLCs are derived from the SAR. The licence holder may not make any change to the design or operation of the reactor that would invalidate the assumptions and conditions on which the current SAR is based without prior approval from ARPANSA.

19.4. Recent amendments to the OPAL OLCs include changes to increase the number of irradiated targets for the production of radiopharmaceuticals, operation of the heavy water purification plant, and application of a flexible fuel management strategy.

iii. operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

19.5. The Regulations require licence applications to contain plans and arrangements to ensure the safety of a reactor throughout all stages of its life. Procedures and instructions for operation, maintenance, inspection and testing of the reactor must form part of these plans and arrangements and are reviewed and approved by ARPANSA before a licence is issued. Details of what is expected in the plans and arrangements are provided in regulatory guidelines.

[23] See http://www.arpansa.gov.au/Regulation/ibp/index.cfm
[24] See http://www.arpansa.gov.au/AboutUs/Collaboration/nucsafety.cfm

19.6. ARPANSA's *Regulatory Assessment Principles* set expectations for an applicant on how to demonstrate that procedures for inspection, testing and maintenance are documented and implemented. The licence holder should also demonstrate that inspection, testing and maintenance throughout the life of the facility ensure the availability and reliability of systems at the levels mentioned in the SAR and avoid common cause failures.

19.7. Approved procedures for the operation, maintenance, inspection and testing of OPAL is undertaken in accordance with the Nuclear Operations Business Management System (BMS). The head document of the BMS is the *Nuclear Operations Business Management System Manual*, and below this lies the range of manuals, procedures, instructions, and forms for all operations, maintenance, testing and inspection activities.

iv. procedures are established for responding to anticipated operational occurrences and to accidents;

19.8. ARPANSA's *Regulatory Assessment Principles* set the expectation on how an applicant should demonstrate that limits of normal operation and anticipated operational occurrences and safety systems settings, including the minimum plant configuration[25], are derived from safety analyses. The applicant is expected to demonstrate that the operation of the reactor will be constrained by the safety settings.

19.9. The applicant must also demonstrate how, at defence in depth level 4, it is possible for operators to diagnose the status of the reactor and to make accident management arrangements. Accident management arrangements may include maintaining or restoring at least one barrier for the confinement of radioactive material and should be based on the outcomes of the safety analysis. The instrumentation important for monitoring the status of the reactor and to undertake effective accident management arrangements is regularly inspected, tested and maintained.

19.10. As with other plans and arrangements that form part of the application, the measures relating to the procedures for responding to anticipated operational occurrences and accidents become mandatory upon issue of licence.

19.11. The Nuclear Operations BMS has 17 procedures dealing with arrangements for symptom-based incidents/emergencies ranging from minor abnormal occurrences to major events, including reactor transients, water leaks and radiation events such as airborne releases or the failure of fuel cladding. These procedures provide guidance on actions which should be taken within the OPAL operations environment and the circumstances under which a wider ANSTO site response is required.

v. necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

19.12. In determining whether to issue a licence to an applicant, the Regulations require ARPANSA to consider whether the applicant has the capacity to comply with the Regulations and any licence condition. ARPANSA's *Regulatory Assessment Principles* set expectations on what an applicant should consider when developing appropriate managerial structure and resources. The regulatory guideline on *Plans and Arrangements* provides guidance on how to demonstrate effective control and

[25] **Minimum plant configuration** is the minimum summary set of reactor systems important to safety (including Engineered Safety Provisions, the Reactor Protection system and the Instrumentation Power Supply System etc) that must be operable during specified reactor states.

management of safety under normal operation, incidents, and accident conditions. To demonstrate this, the licence holder should show the availability of all necessary engineering and technical support resources in all safety-related fields.

19.13. ANSTO has a corporate plan which identifies the development and retention of technical and engineering skills in its human resources, which will support safe operation of all its facilities. There is a human resource plan for Nuclear Operations, which is reviewed annually.

vi. incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;

19.14. The Regulations requires every licence holder to report any accident to ARPANSA within 24 hours of its occurrence. Guidance on reporting accidents is provided in the ARPANSA website[26]. In addition, a licence holder is required to report the breach of any licence condition to ARPANSA within a reasonable time after the breach is first discovered.

19.15. Under the Nuclear Operations BMS, ANSTO implements a process for identifying, recording, analysing and reporting abnormal occurrences and accidents to ARPANSA within appropriate timeframes.

vii. programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;

19.16. ARPANSA's *Regulatory Assessment Principles* set expectations for an operating organisation to have mechanisms :

- for assessment, verification and feedback, including through utilisation of independent reviews;
- to review and audit all activities important to safety and establish an ongoing safety assessment program;
- to learn lessons from operating experience and safety research from within the organisation and internationally,
- to analyse abnormal occurrences, incidents and safety performance of similar reactors worldwide
- to ensure that results of periodic testing, maintenance and modifications, and emergency preparedness exercises are fed back into safety analyses, design modifications, procedures and quality assurance systems;

19.17. ANSTO's Reactor Operations Event Management System (ROEMS) has recently been replaced with a more advanced event management system within the Governance Risk and Compliance (GRC) system. The system is used to manage and record all events, including abnormal occurrences, incidents and near misses. The system is also used to detail the investigations and analyses related to those events. ANSTO is required to report to ARPANSA within 24 hours all events at INES Level 2 and above. However, ANSTO also voluntarily sends quarterly reports to ARPANSA on all nuclear safety-related events at INES level 1. Australia

[26] http://www.arpansa.gov.au/regulation/licenceholders/incident.cfm

supports the IAEA Incident Reporting System for Research Reactors (IRSRR). Programmes for corrective actions and learning lessons from incidents are integral to ANSTO's Event Management System.

19.18. ANSTO has, since 2006, taken part in a collaboration agreement with operators of the SAFARI-1 reactor (South Africa) and High Flux Reactor (HFR - The Netherlands). The aim of the agreement is to work together to increase safety and reliability through cooperation as OPAL, SAFARI-1 and HFR are similar reactors. Meetings are held every 12 to 18 months to exchange ideas, experiences and good practices. (***This is also an example of how Australia meets Challenge 3 identified at the 6th Review Meeting on how to make better use of operating and regulatory experience.***)

viii. the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

19.19. In relation to the handling, storage, transport, discharge and disposal of any radioactive waste attributable to a nuclear reactor, ARPANSA's guidelines set expectations that:

- suitable provisions, including waste management facilities, must exist for radioactive waste arising from operations;
- where radioactive waste is stored prior to being discharged or disposed of, there are to be suitable provisions for its interim containment;
- handling facilities for radioactive waste are to be sufficiently flexible to cope with faulty containers, and radioactive waste of non-standard physical or chemical composition;
- the form, locations and quantities of any radioactive waste or discharges, are to be specified, monitored and recorded; and
- where relevant, the safety analysis is to include consideration of radioactive waste and to confirm compliance with the radiation dose limits.

19.20. ARPANSA provides guidance on a range of radioactive waste and disposal matters, drawing on IAEA guidance. It includes a requirement for the applicant to provide documentation detailing procedures for the minimisation of the generation of radioactive waste.

Management of spent fuel and radioactive waste

19.21. Detailed procedures for waste management at OPAL are included in the Nuclear Operations BMS. Solid and liquid radioactive wastes are managed across the whole of the ANSTO site by ANSTO's Waste Management Services within Nuclear Services Group of the Nuclear Operations Division.

19.22. OPAL's radioactive waste management plan addresses waste minimisation, segregation and classification of the different waste types and waste streams. Intermediate level solid waste is stored in the OPAL service pool. The low-level liquid waste is managed under the existing Waste Management Services arrangements for discharge to the sewer under the trade waste agreement (TWA) with Sydney Water as approved by ARPANSA. The TWA requires that, by the time discharges from Lucas Heights reach the sewage treatment plant, the levels of

radioactivity comply with the WHO derived concentration limits for drinking water. OPAL liquid discharges are part of the site general discharges.

Limiting exposure during handling, treatment, transport, storage and transfer or ultimate disposal of spent fuel and radioactive waste

19.23. Limitation of exposure is implemented by ANSTO through guidance documents and work instructions in the WHS management system and the Nuclear Operations BMS. The guidance and instructions comply with all applicable ARPANSA and international codes and standards.

Packaging and containment of radioactive waste

19.24. All solid waste is stored on-site in approved packaging in facilities specifically designed and licensed for this purpose. Prior to discharge, all radioactive liquid waste is stored in appropriate containment vessels and subject to appropriate treatment methods. A program is in place for the solidification of intermediate level radioactive liquid wastes from molybdenum-99 production using ANSTO's patented SYNROC process at the proposed ANSTO SyMo Facility. A siting and construction licence for this facility was issued in 2014[27].

Interim storage of spent fuel and radioactive waste

19.25. After removal from OPAL, the spent fuel elements are transferred to the service pool, which has a capacity to store spent fuel arising from ten years of reactor operation. ANSTO is currently proposing that used uranium silicide fuel from the operation of OPAL will be shipped to France for reprocessing. The intermediate waste will be solidified and returned to Australia in a vitrified form.

Discharge reports

19.26. The low-level liquid waste generated by OPAL is initially stored within the reactor building, followed by storage if required in the various Waste Management Services facilities on the ANSTO site. The waste is then ultimately discharged to the Sydney Water sewer as part of the site general discharges as agreed with ARPANSA. Wastes are characterised both before discharge from OPAL to the site facilities and from the site.

19.27. The OPAL operating licence has conditions requiring quarterly and annual reports to ARPANSA on airborne radioactivity discharges arising from all of ANSTO's activities. The existing stack monitoring equipment continuously sample gaseous discharges using TC45 cartridges. The filters are measured weekly by ANSTO's Nuclear Assurance Group to provide information on gaseous discharges. Notification and Correction Levels are set by ARPANSA. Currently, discharges are well within the Notification Levels that are set by ARPANSA in the licence.

Management of ultimate disposal or transfer of radioactive wastes

19.28. In accordance with its Radioactive Waste Management Policy, ANSTO stores its radioactive wastes on site until suitable disposal routes are available. There is now no disposal route for radioactive waste within Australia and this limits the options to on-site storage or return to manufacturer.

[27] See http://www.arpansa.gov.au/News/whatsnew/news1_140513.cfm

Spent fuel management strategy

19.29. The Australian Government decided in 1997 that an appropriate management strategy for HIFAR spent fuel was to ship it overseas and store any resulting long-lived intermediate level wastes in Australia in a form suitable for acceptance into a national storage facility. Reprocessed wastes from those shipments were returned to Australia in 2015 to an Interim Waste Store (IWS) at ANSTO's Lucas Heights site to temporarily store these wastes until establishment of a centralised national storage facility. (See para vii above).

19.30. The current intention is to send the OPAL spent fuel overseas for reprocessing in France, with the intermediate level waste to be returned to Australia for storage. No ultimate disposal route has been established by the Australian Government.

Action taken from lessons learnt from the Fukushima Daiichi accident

19.31. ANSTO undertook self-assessment against the lessons learnt from Fukushima accident. The actions arising from the self-assessment, which coincided with the OPAL PSR, were not significant for safety and did not require immediate action. The actions have been prioritised and their implementation continues to be monitored by ARPANSA. Some of the actions have already been implemented.

19.32. The self-assessment was revised more recently. The latest revision of the self-assessment was in 2014, when ANSTO conducted the review against the IAEA Safety Reports Series No. 80 *Guidance Safety Reassessment for Research Reactors in the Light of Accident at the Fukushima Daiichi NPP*. This review has not been formally completed yet.

Glossary and acronyms

ABMS	ANSTO Business Management System
ANSTO	Australian Nuclear Science and Technology Organisation
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
BMS	Business Management System
CEO	Chief Executive Officer
CNS	Convention on Nuclear Safety
FSAR	Final Safety Analysis Report
GIF	Generation IV International Forum
GRS	ANSTO's Governance Risk and Compliance system
HF	Human Factors
HIFAR	High Flux Australian Reactor
IAEA	International Atomic Energy Agency
INES	International Nuclear Event Scale
IRSRR	IAEA Incident Reporting System for Research Reactors
ISO	International Organization for Standardization
IWS	Interim Waste Store
LEU	low enriched uranium
Licence	A legal authorisation issued to an applicant by ARPANSA to site, construct, operate, decommission, dispose of or abandon a nuclear research reactor or other radiation facilities or sources.
MW	megawatt
New South Wales	One of the six states in Australia and the one in which ANSTO is located
NRWMF	National Radioactive Waste Management Facility
Nuclear installation	'Nuclear installation' is defined in the CNS as any land-based civil nuclear power plant under the jurisdiction of the Contracting Party including such storage, handling and treatment facilities for radioactive materials as are on the same site and are directly related to the operation of the nuclear power plant. Such a plant ceases to be a nuclear installation when all nuclear fuel elements have been removed permanently from the reactor core and have been stored safely in accordance with approved procedures, and a decommissioning program has been agreed by the regulatory body. Australia has no nuclear power plant, and none are planned. This report addresses Australia's only operating nuclear research reactor.
OLC	Operational Limits and Conditions
OPAL	Open Pool Australia Light-water reactor

POAC	Performance Objectives and Criteria
PSR	Periodic Safety Review
PSAR	Preliminary Safety Analysis Report
PSSR	Periodic Safety and Security Review
QA	Quality Assurance
QMS	Quality Management System
RAC	ANSTO's Reactor Assessment Committee
Regulatory body	'Regulatory body' is defined in the CNS as any body or bodies given the legal authority by the Contracting Party to grant licences and to regulate the siting, design, construction, commissioning, operation or decommissioning of nuclear installations
ROEMS	ANSTO's Reactor Operations Event Management System
RPA	Radiation Protection Adviser
RSB	ARPANSA's Regulatory Services Branch
SAR	Safety Analysis Report
SLA	Service level agreement
SPI	Safety Performance Indicator
SYNROC	SYNROC (synthetic-rock) is an ANSTO-developed technology to transform the intermediate level liquid wastes generated from the Mo-99 production process into a stable immobilised glass ceramic form. The technology greatly reduces the waste volume and converts it into a long-term stable form.
SyMo Facility	A facility under construction in ANSTO to apply Synroc technology for immobilisation of waste from ANSTO's Mo-99 production processes
the Act	*Australian Radiation Protection and Nuclear Safety Act 1998*
the Regulations	Australian Radiation Protection and Nuclear Safety Regulations 1999
TIS	Trusted International Standards
TWA	Trade Waste Agreement
US NRC	US Nuclear Regulatory Commission
WHO	World Health Organisation
WHSE	Work Health, Safety and Environment