Australian Government

Australian Radiation Protection and Nuclear Safety Agency

QUARTERLY REPORT
OF THE
CHIEF EXECUTIVE OFFICER
OF ARPANSA
FOR THE PERIOD 1 JANUARY 2008 TO 31 MARCH 2008
and
A report to Parliament under Section 61 of the ARPANS Act 1998

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Australian Radiation Protection and Nuclear Safety Agency

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Further Information About This Publication

If you would like to know more about the content of this publication please contact ARPANSA's Manager Policy and Security of Sources on 1800 022 333 or e-mail at info@arpansa.gov.au. Further information about ARPANSA can be found on the Agency's website at www.arpansa.gov.au.

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Letter of Transmittal

7 May 2008

Senator the Hon Jan McLucas
Parliamentary Secretary to the Minister
for Health and Ageing
Parliament House
Canberra ACT 2600

Dear Parliamentary Secretary

The *Australian Radiation Protection and Nuclear Safety Act 1998* (the Act) requires the Chief Executive Officer of the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) to submit to the Minister, at the end of each quarter, a report on:

- the operations during the quarter of the CEO, ARPANSA, the Radiation Health and Safety Advisory Council (the Council), the Nuclear Safety Committee (the NSC) and the Radiation Health Committee (the RHC);
- details of any direction given by the Minister to the CEO under Section 16 of the Act;
- any breach of licence conditions by a licensee, of which the CEO is aware;
- all reports received by the CEO from the Council and the NSC under paragraph 20(f) or 26(1)(d) of the Act; and
- a list of facilities licensed under Part 5 of the Act.

I am pleased to provide you with a report, meeting the requirements of the Act, covering the period 1 January 2008 to 31 March 2008.

As you would be aware, Section 60(6) of the Act requires you to cause a copy of the report to be laid before each House of the Parliament within 15 sitting days of the day on which this report was given to you.

Section 61 of the Act permits the CEO to cause a copy of a report relating to the CEO's functions to be tabled in either House of the Parliament and that a copy of the report be given to the Minister. I have included in the quarterly report a report under Section 61 of the ARPANS Act in relation to my decision on an application by ANSTO for the OPAL reactor.

Yours sincerely

John Loy
CEO of ARPANSA

Report on the operations of the CEO and ARPANSA

The report on the operations of the CEO and ARPANSA is based on the agency's three output groups:

- knowledge, information and services;
- national leadership in radiation protection and nuclear safety; and
- regulation.

Knowledge, information and services

Non-ionizing radiation

ULTRAVIOLET RADIATION (UVR)

ARPANSA continues to work on possible regulation of solaria with a working group of ARPANSA staff and a number of state representatives formulating a Draft Uniform Requirements Document for use by state regulators. As part of their undertakings to the Standards Australia Committee on Solaria CS64, ARPANSA staff have made further visits to solaria in Melbourne to make spectral measurements of sunbed emissions. The data will be presented to the September meeting of SAA CS64 Solaria and will also be used in subsequent publications looking at the impact of solaria on public health.

ARPANSA staff also attended a Meeting of Standards Aust CS64 Solaria in Sydney in February. Measurement data from ARPANSA visits to solaria provided valuable input into the committee's deliberations. This meeting was productive with the solarium industry agreeing to lower limits on sunbed emissions and to apply more stringent age limits on solarium users.

ARPANSA staff attended a Meeting of Standards Aust CS42 Sunscreen Agents in Sydney in February. This committee has been working on increasing SPFs from 30+ to 50+ for approximately five years and some progress has finally been made.

Testing of the protective effectiveness of two new hat styles against solar ultraviolet radiation for the New Zealand Cancer Council was undertaken and completed in February 2008. The UV Protection Factor (UPF) testing area contributed a brief advertisement on UPF testing in the 2008 Year Book distributed to all South Australian surf lifesaving clubs

Measured ultraviolet radiation (UVR) data for the ARPANSA Australian mainland measurement sites for the period 1996-2007 was provided to the Australian National University for the AusImmune study.

Other enquiries on solar UVR levels were received from the Instituto de Salud Publica de Chile as well as from research students at a number of Australian Universities and from the general public.

Requests for information on solaria were received from the Green Party Parliamentary Officer, NZ as well as from the public. Numerous requests for information were also received on compact fluorescent lamps.

ARPANSA UVR measurement data for the Antarctic stations has been provided to the Australian Antarctic Data Centre. ARPANSA UVR data for Australia continues to be displayed live on the internet for Melbourne, Sydney, Darwin, Adelaide, Brisbane, Townsville, Newcastle, Kingston (outside Hobart) and Perth. It is planned to add Alice Springs and possibly Canberra during 2008.

Two papers on the health impacts of solaria done by the Queensland Institute of Medical Research in collaboration with ARPANSA staff have been submitted to scientific journals.

A collaborative paper with the University of Hawaii on "A day at the beach while on tropical vacation: Sun protection practices in a high-risk setting for UVR exposure" has been accepted for publication in Archives Dermatology.

ARPANSA staff have refereed manuscripts for the Journal of Atmospheric Chemistry and Physics and for the Journal of Photobiological Sciences.

ARPANSA staff contributed a short paper on UV at the Antarctic stations to a National Report on Ozone and UV measurements in Australia and Antarctica, to be submitted to the 7th World Meteorological Organization and United Nations Environment Programme Ozone Research Managers Meeting, 19 – 21 May 2008, Geneva, Switzerland.

A film crew from NHK Japanese TV visited the ARPANSA Yallambie laboratory on 31st January to film footage on UV measurements and testing for a documentary on skin cancer.

ARPANSA staff attended a UV Alert Meeting at Cancer Council Victoria in February.

ELECTROMAGNETIC RADIATION (EMR)

At the request of the Australian Broadcasting Commission an ARPANSA officer visited the ABC Mt Coot-tha studios on 23 and 24 January 2008 to undertake measurements of extremely low frequency (ELF) magnetic fields. Following the investigation of a cluster of breast cancer cases among staff at the ABC Toowong studios, these studios were evacuated and staff relocated to Mt Coot-tha. The report on the measurements concluded that: "magnetic field levels were typical of ambient levels in residences and offices. Although there were brief excursions to considerably higher levels when staff were in close proximity to certain electrical equipment, these are comparable to levels experienced in the usual home environment when using electrical appliances."

ARPANSA staff provided information to state and Australian government agencies and to the public and media regarding EMR and health. The most common category of enquiries were in regard to possible health effects of magnetic fields from electricity distribution, particularly high-voltage transmission lines and sub-stations or transformers. Enquiries regarding other electrical devices, including microwave ovens, satellite dishes, computers and wireless technologies, including primarily mobile phone base stations were also numerous. Other calls concerned occupational exposures to radio and radar installations.

A meeting of the working group preparing the Standard on exposure to extremely low frequency electric and magnetic fields was held at ARPANSA on 15 – 16 January. The meetings continued consideration of the public submissions received following the release of a draft of the Standard for public consultation. A one day forum to discuss the draft Standard and public submissions was held on 27 February. This was attended by members of the

consultative group associated with the Standard development and representatives of the electrical power industry. Attendees were provided with information relating to how the Standard is expected to change following consideration of public submissions and a timetable for the future was given.

PUBLICATIONS

Karipidis K, Benke G and Sim M (2008). "Feasibility of constructing the radiation component of an Australian job-exposure matrix", The Journal of Occupational Health and Safety: Australia and New Zealand, 24(1), 53-62.

O'Riordan DL, Steffen AD , Lunde KB and Gies P. "A Day at the beach while on tropical vacation: Sun protection practices in a high risk setting for UVR exposure ". Archives Dermatology (accepted for publication).

Medical radiation

RADIATION IN HEALTH CARE – SAFER AND BETTER USE

This program is being implemented by:

- the purchase and operation by ARPANSA of a state-of-the-art medical linear accelerator (linac); and
- actively engaging with the medical professions, providing training and access to research facilities for persons working in the medical radiation field and by providing radiation dose information, and information on techniques to reduce radiation doses to patients and occupationally exposed persons.

The tender for a medical linear accelerator received from Elekta complied fully with the requirement for multiple photon beam energies, and has been accepted. A contract has been negotiated that incorporates the matching of beam specifications to the accelerator being supplied by Elekta to the National Physical Laboratory (UK) with a similar energy configuration.

Further information has been provided as part of the application for a licence under the ARPANS Act to operate the medical linac.

PERSONAL RADIATION MONITORING SERVICE (PRMS)

The ARPANSA PRMS has continued to offer a comprehensive radiation monitoring service for persons who may be exposed to ionizing radiation as a consequence of their occupation. A service is also provided for the measurement of radon and natural background radiation levels.

The first phase of enhancements to the PRMS database application has been completed and implemented. Several more phases are anticipated during the next 6 months. Arrangements for maintenance and enhancement of the software beyond that period are still to be determined.

Revised filter specifications for the new monitor holder have been communicated to the supplier who will deliver a series of new prototypes for another round of testing. It is

anticipated that these tests will identify an acceptable configuration, allowing the project to be concluded.

IONIZING RADIATION STANDARDS (IRS) – CALIBRATION SERVICES

The national therapy quality assurance dosimetry audit program in radiotherapy treatment centres was recommenced in July 2007 after the first round was undertaken in 2003. Improved correction factors for the reference dose measurement using thermoluminescent dosimetric material (TLD) and for the determination of the quality of megavoltage x-ray treatment beams have been developed. To date, a total of 12 beams from 5 treatment centres have been audited. The results so far have been within the 3.5% criterion. Two photon beams have been re-audited from a centre where the previous results differed sufficiently from expected values. The new results are more consistent within the measurement uncertainty. A study of the earlier results has suggested possible contamination of capsules containing the TLD material.

MEDICAL PHYSICS

The development of a national survey of radiation doses from Computed Tomography (CT) is continuing. A major aim of the survey is to measure the impact of new technologies and procedures on patient doses in CT.

RADIOPHARMACEUTICAL

The 2008 testing program for radiopharmaceuticals has been agreed to by ARPANSA and the TGA.

Environmental Radiation

HEALTH PHYSICS

Monitoring and Surveillance Group

The software system, ARGOS (Accident Reporting and Guidance Operational System) is a decision support system for chemical, biological, radiological and Nuclear (CBRN) emergencies. ARPANSA is coordinating a national project to evaluate the suitability ARGOS for Australian CBRN emergency planning. ARPANSA has successfully distributed, installed and provided training for ARGOS software to all key stakeholder members. As a part of the evaluation, various scenarios for the crash-landing of the US military satellite (USA-193) were developed and evaluated. A technical report was generated.

A project was completed that reviewed the activity concentrations values used for the exclusion, exemption and clearance of bulk materials as defined in the document *Derivation of Activity Concentration Values for Exclusion, Exemption and Clearance, (SRS 44, IAEA, 2005)*. A standard set of radiological scenarios referring to external irradiation, dust inhalation and ingestion for target radionuclides was generated. This project was successfully completed by the ARPANSA graduates.

ARPANSA staff were guest editors of a special issue of the Journal of Environmental Radioactivity (Volume 99, Issue 3) that published the conference proceedings from the 2006 South Pacific Environmental Radioactivity Association (SPERA) Conference The Radon Calibration Laboratory provided six radon-222 standard exposures for calibration of the

ARPANSA radon dosimetry service maintained by the Personal Radiation Monitoring Service (PRMS).

ARPANSA provided comment and advice regarding the potential health impacts of exposure to cosmic radiation received during air-flight and the effects of ionizing radiation on the thyroid.

Advice was provided on the potential health impact of exposure to the public from lost sealed sources.

Information was supplied to the Nuclear Energy Agency (NEA) Committee on Radiation Protection and Public Health on the awareness of issues related to radon exposure in Australia.

Radiation Emergency Operations

ARPANSA staff conducted specialist training for radiation emergency response at the Yallambie site.

ARPANSA staff participated in Exercise Boomerang Crossing in Canberra in February with Australian and US Agencies.

Emergency Preparedness

ARPANSA provided a radiation expert for the Crisis Advisory Panel of Experts and through the Radiation Emergency Operations Unit maintained a 24 hour radiation emergency duty officer to provide access to ARPANSA resources and expertise.

In February, ARPANSA participated in a meeting of the Visiting Ships Panel (Nuclear) to provide expert advice on radiation protection and health physics issues, as part of the Australian planning to allow visits by nuclear powered warships. ARPANSA now chairs the Technical Working Group of the VSP(N).

In its role as the Australian National Competent Authority for Radiation Emergencies, ARPANSA approved the nomination of radiation emergency teams from the Australian Nuclear Science and Technology Organisation for registration into IAEA Radiation Assistance Network.

ENVIRONMENTAL RADIOACTIVITY

ARPANSA took part in a world-wide open proficiency test for gamma emitting radionuclides in soil, spinach and water organised by the IAEA. All except three results were acceptable. Of the three that failed, the results passed on trueness but failed on precision due to size of the uncertainty allowed for because of true coincidence summing.

A technical report (*Environment Radioactivity Monitoring in Australia 2005 and 2006*) summarising environmental monitoring by ARPANSA over the last two years is in its final draft form and will be published in the next quarter.

Public communications activities

During January to March 2008 there were 249 856 visitors to the ARPANSA website. Most popular was the web page providing realtime UV index values for Melbourne. Also popular were radiation and health fact sheets and pages dealing with the basics of radiation science.

Visitors downloaded 45 328 documents. Most popular were magnetic field fact sheets and documents from the ARPANSA Radiation Protection series which can be found at www.arpansa.gov.au/Publications/codes/rps.cfm .

National leadership in radiation protection and nuclear safety

Comprehensive Test Ban Treaty – air sampling monitoring systems

As part of Australia's commitment to the Comprehensive Nuclear-Test-Ban Treaty (CTBT), ARPANSA continued to operate and maintain radionuclide air monitoring stations at Melbourne, Perth, Townsville, Darwin, and the Cocos Islands, Australia. The two remaining stations to be installed are located at Macquarie Island and Mawson, Antarctica.

In December 2007, a revised proposal for a radionuclide station at Macquarie Island was submitted to the CTBTO, taking into account the financial concerns initially raised. Additionally, in January 2008, a letter was received from the AAD confirming the viability of the Mawson base to host a radionuclide station. Unfortunately, due to the severe financial shortfall of assessed contributions from member states, the CTBTO decided to defer the installation of these two stations until 2010/2011.

ARPANSA has constructed, operated and maintained the radionuclide station at Kavieng, Papua New Guinea (PNG). However, as of September 2006, responsibility for this station transferred to the PNG National Weather Service. In March 2008, a Request for Quotation (RFQ) was issued by CTBTO for the installation of a new High Purity Germanium detector and the replacement of various station equipment at the Kavieng station. ARPANSA will respond to the RFQ.

In addition to operating the stations, ARPANSA also operates the Australian Radionuclide Laboratory, which has the role of testing samples obtained by other monitoring stations. The Laboratory operates under contract to CTBTO.

ARPANSA continues to maintain a National Data Centre (NDC) that provides advice to the Australian Safeguards and Non-Proliferation Office (ASNO) on any event detected by the CTBT radionuclide network that may be indicative of a nuclear weapon test explosion. ARPANSA is in the process of negotiating an MOU with ASNO with regard to the provision of limited NDC services that are both timely and effective.

National Uniformity

The main vehicle for the promotion of national uniformity of radiation protection throughout the jurisdictions is the National Directory for Radiation Protection which is jointly developed by ARPANSA with the State and Territory jurisdictions through the Radiation Health Committee (RHC). During the quarter the following were highlights of this program:

- Development of a number of individual proposals for amendment to the National Directory for Radiation Protection has continued.
- The Codes published since edition 1 of the National Directory had already been through a regulatory impact assessment and consultation process, and therefore could proceed to be adopted in the Directory. RHC members voted in January 2008 to include RPS5 (portable gauges), RPS8 (research), RPS9 (mining), RPS10 (dentistry), RPS11 (security), RPS12 (UV) and RPS13 (fixed gauges) in the National Directory, and in February 2008 to include the 2008 revision of RPS2 (transport). A paper seeking Australian Health Ministers Advisory Council endorsement of inclusion of these publications in the National Directory was prepared.
- Separate amendments to the National Directory include exemptions and exclusions, user disposal of low level radioactive waste, use of intense pulsed light sources and lasers on humans, solaria, new Annexes, certification of personal monitoring services, competencies, incident reporting, and nuclear installations. Public consultation will be required for each of the amendments and regulatory impact assessment requirements will need to be met. In some cases a full regulatory impact assessment may not be required, as the impact of the changes is not significant. Several of the amendments have been prepared and regulatory impact assessment work commenced. It is expected that the majority of the amendments will be released for consultation during the year.
- Consultancies are to be arranged to complete reviews of competencies and registration requirements.

International Activities

ARPANSA officers attend the following international events:

- the 16th Meeting of the IAEA Transport Safety Standard Committee in Vienna, 3-7 March 2008. The 2009 Edition of the IAEA Regulations for Safe Transport of Radioactive Material, TS-R-1 was finalised and approved for publication at this meeting. Issues in relation to denial of shipment, harmonisation of international regulations, and security in transport of radioactive material, progress on the coordinated research program on Naturally Occurring Radioactive Material and accident severity during air transport of radioactive material were discussed.
- OECD-NEA Radioactive Waste Management Committee (RWMC) and RWMC Regulators' Forum at OECD Headquarters, Paris, between 11-14 March 2008. The aim of the RWMC and RWMC Regulator's Forum is to share experience, and foster best practice in radioactive waste management activities in NEA countries, including licensing of waste repositories.
- IAEA Radiation Safety Standards Committee (RASSC) meeting held in Vienna, Austria from 31 March - 2 April 2008, including discussions on the development of a range of IAEA Safety Standards, the overall structure of the Standards and the revision of the International Basic Safety Standards.
- ARPANSA officers submitted a report on electromagnetic radiation related activities and events in Australia to the meeting of the New Zealand Interagency Committee on the Health Effects of Non-Ionising Fields held on Wednesday 13 February 2008 in Wellington.

The CEO visited Spain from 26 January - 9 February to take part in the IAEA's Integrated Regulatory Review Service (IRRS) Mission to that country. The CEO acted as deputy team

leader for the mission that included 18 international experts from 15 different Member states of the IAEA.

Regulation of the Commonwealth's uses of radioactive material, apparatus and facilities

Regulatory process and performance

COMMUNICATION

A new single shared email inbox has been established for all electronic regulatory communication. An email was sent to all licence holder representatives as follows:

> "Dear Licence holder representatives
>
> Please note that we have now established one email inbox for all regulatory communication.
>
> I request that rather than send emails directly to various regulatory officers as in the past you now send them to the one inbox as indicated below. You will receive an acknowledgement followed by a timely response.
>
> Email to licenceadmin@arpansa.gov.au
>
> This mailbox is intended to be used for receiving and sending all emails including
>
> - Licence holder Quarterly Reports
> - Regulation 51, 53, 54 and 55 requests for approval
> - New licence applications (note that the accompanying licence application fee must be sent separately and a system will be in place to enable this to be done electronically by July 2008)
> - General Regulatory inquiries and communication
>
> If it is an ongoing matter requiring the attention of a particular officer please mark it accordingly.
>
> This will enable us to monitor all incoming emails to ensure they receive a prompt response particularly in the event that any particular officer is not available.
>
> Thank you for your co-operation.
>
> Rhonda Evans
> Director Regulatory and Policy Branch"

GUIDELINES

The guidelines and forms for licence application have been revised and are available on the ARPANSA website. The intention was to simplify them and make them easier to use.

ARPANSA is preparing regulatory guidance for ARPANSA licensees on the requirements to extend the recommended working lives of sources in neutron moisture meters and soil moisture density gauges.

QUALITY MANAGEMENT

ARPANSA has begun the process of revising and improving the regulatory quality management system. The intention is to ensure that the regulatory processes are managed according to a comprehensive quality management system (QMS) which meets the ISO 9000 standard. The regulatory processes are viewed as services which are provided to clients, including the licence holders and these services should be consistently provided according to a high standard of quality which satisfies the needs of the client. The following steps are being progressively implemented:

- A quality committee is in place and is meeting regularly;
- A quality officer and quality team have been established;
- Quality working groups are developing quality management and operational policy and procedures; and
- A consultant has been engaged to assist and facilitate the establishment of the revised QMS.

REGULATORY KEY PERFORMANCE INDICATORS (KPI'S) REGULATORY

The techniques for collecting the performance data from the new Regulatory Management Information System are being progressively refined to ensure the accuracy and completeness of the data collected.

The progressive performance against the targets for the three quarters of this year is reported in the following table.

PROGRESS AGAINST KPI'S 2007/2008

Measure	Sept 2007	Dec 2007	March 2008	Annual Target
Effectiveness				
1. Accidents/incidents that must be reported within 24 hours	0	0	0	< 5
2. Potential accidents/incidents	12	4	0	< 40
3. Percentage of actual accident/incidents reported by licence holders	100%	100%	100%	> 80%
4. Non-compliances (breaches)	0	3	2	< 40
5. Percentage non-compliances reported by licence holders	NA	0%	100%	> 80%
6. Applications for Licence	3	3	4	-
7. Percentage licence applications accepted as valid	100%	100%	100%	> 80%

Measure	Sept 2007	Dec 2007	March 2008	Annual Target
8. Percentage assessment reports for applications for licence	100%	100%	100%	100%
9. Percentage correct decisions for licence applications	100%	100%	100%	100%
10. Requests for Approval (Regs 51, 53, 54, 55)	10	5	8	-
11. Assessment Reports	6	9	9	-
12. Percentage positive decisions for requests for approval	100%	100%	100%	>80%
13. Inspection Reports	9	9	7	> 80
14. Licence Holder Compliance Reports	86	87	96	-
15. Percentage licence Holder Compliance Reports received on or before due date	Note a	Note a	Note a	> 80%
Efficiency				
16. Percentage of ministerial responses meet target date set in agreement with Department	100%	100%	100%	> 80%
17. Number of inspection and assessment reports per staff member (14 inspectors)	1	1.3	1.1	> 10
18. Expenditure/budget	<100%	<100%	<100%	< 100%
19. Revenue/budget	Note a	Note a	Note a	100%
20. Percentage staff training completed (%)	>80%	>80%	>80%	> 80%
21. Time to provide requested information to stakeholders	Note a	Note a	Note a	< 30 days
22. Average time to report inspections	38 days	81 days	76 days	< 30 days
23. Time to review Licence Holder Reports	Note a	Note a	Note a	< 30 days
24. Time to review Applications for Licence	Note a	133 days	93 days	< 60 days
25. Time to review requests for approval (Regs 53, 54, 55)	75 days	1 day	8 days	< 30 days
26. Time to review requests for approval (Reg 51)	75 days	26 days	110 days	< 60 days
27. Time to complete investigation of incidents/accidents	Note a	Note a	NA	< 60 days
28. Time to complete investigation of non-compliances	NA	Note a	Note a	< 60 days
Stakeholder Satisfaction				
29. Satisfaction Surveys – Overall Service	Note b	Note b	Note b	> 80%

Measure	Sept 2007	Dec 2007	March 2008	Annual Target
30. Complaints	0	3	0	< 20
31. Compliments/commendations	0	1	0	> 5
32. Reports to ARPANSA Executive as planned	100%	100%	100%	100%
Enforcement				
33. Educational, awareness, information sessions and short presentations for licence holders	0	0	0	> 3
34. Corrective measures	Note a	Note a	Note a	> 40
35. Formal Directions	0	0	0	> 0
36. Percentage suspensions and cancellation of licences	0	0	0	> 0%

Notes

a. Regulatory processes being further developed to capture these measures

b. No surveys were carried out during the quarter. A survey is planned for June 2008.

The annual targets were derived based by estimation only. They will be progressively refined over time as actual data is collected and trends can be determined.

Regulatory Activities

The CEO of ARPANSA is responsible for regulating all radiation and nuclear activities undertaken by Australian Government entities and contractors who undertake such activities for or on behalf of Australian Government entities.

ARPANSA officers assist the CEO to implement the regulatory scheme set out in the ARPANS legislation in particular by providing assessments and advice in connection with applications for source and facility licences under the ARPANS Act, including whether or not a licence should be issued, authorising dealings with radiation sources and conduct undertaken in relation to facilities, both prescribed radiation facilities and nuclear installations.

Monitoring compliance with the ARPANS legislative scheme for regulation, including by undertaking inspections and providing advice to the CEO on findings of breach of the Act and any subsequent recommendation as to enforcement action, is a major output of ARPANSA. Compliance monitoring includes the review of compliance reports submitted by licence holders.

The Mersey Hospital Tasmania is the first public hospital which falls within the ARPANS jurisdiction. A site visit was made to the Mersey Hospital and a presentation on the ARPANSA regulatory framework was given to the CEO and senior management of the hospital. A site visit report was produced. The object of this presentation and site visit was to

provide information to the hospital to facilitate their application for an ARPANSA source licence.

REVIEW OF ANSTO SUBMISSION (E0083 FUEL ASSEMBLY DESIGN MODIFICATION TO INCORPORATE A STOPPER

The main nuclear safety activity undertaken during the quarter was in relation to the review of the ANSTO submission (E0083 Fuel Assembly Design Modification to Incorporate a Stopper). This submission was received by ARPANSA on 21 December 2007.

ANSTO's request to modify the OPAL Fuel Assembly design and to operate the OPAL reactor using fuel manufactured or modified to that design arose out of ANSTO's analysis of the cause of fuel plate displacements that had been detected during the commissioning of the reactor.

ANSTO's requests for approval are requests under licence condition imposed by Regulation 51 of the ARPANS Regulations 1999.

The key activity during the quarter was the review of the submission including the provision of detailed questions to ANSTO, external experts' review of aspects of the submission and the analysis of the independent Nuclear Safety Committee. ANSTO provided comprehensive responses to these questions and undertook further analysis in response to the issues raised by external experts.

The review of the submission and the decision of the CEO of ARPANSA was published on 1 May 2008, outside of the March quarter. The decision of the CEO of ARPANSA was to approve the modification of the design of the fuel assemblies; to limit the approval of modification of the design of the Fuel Assemblies to fuel manufactured by the French company CERCA; to allow ANSTO to load the fuel as the first stage of its Return to Service Program.

A full report to the Parliament on this submission is published with this Quarterly Report.

INSPECTIONS - ANNOUNCED

Licensee	Licence Number	Location
Australian Customs Service	F0155	Fremantle Container Examination Facility, WA
CSIRO Land and Water	S0009	Black Mountain, Canberra, ACT
CSIRO Molecular Health and Technologies	S0016	Clayton, VIC
CSIRO Molecular Health and Technologies	S0016	North Ryde, NSW
CSIRO Entomology	S0017	Black Mountain, Canberra, ACT

Licensee	Licence Number	Location
ANU, Research School of Physical Sciences and Eng.	S0027	Acton Campus, Canberra, ACT
ANU, Research School of Physical Sciences and Engineering	S0027	Acton Campus, Canberra, ACT
ANU, Research School of Biological Sciences	S0027	Acton Campus, Canberra, ACT
ANU, John Curtin School of Medical Research	S0027	Acton Campus, Canberra, ACT
Defence	S0042	Derwent Barracks, Hobart, TAS
Defence	S0042	79 Squadron, RAAF Pearce, WA
Defence	S0042	Base Armament Unit, RAAF Pearce, WA
Defence	S0042	Airflite Pearce, RAAF Pearce, WA
Defence	S0042	Facility Support Unit, HMAS Stirling, WA
Defence	S0042	Special Air Service Regiment, Campbell Barracks, WA
CSIRO Forest Biosciences	S0054	Hobart, TAS
CSIRO Forest Biosciences	S0054	Clayton, VIC
Australian Federal Police	S0056	Perth Airport, WA
CSIRO Minerals	S0064	Lucas Heights, NSW
CSIRO Minerals	S0064	Clayton, VIC
CSIRO Materials Science and Engineering (formerly Manufacturing and Materials Technology)	S0066	Clayton, VIC
Department of Foreign Affairs and Trade	S0079	Canberra, ACT
Australian War Memorial	S0080	Canberra, ACT
Australian Customs Service	S0092	Fremantle Pallet X-ray Unit, WA

Licensee	Licence Number	Location
CSIRO Materials Science and Engineering (formerly Industrial Physics)	S0105	Lindfield, NSW
ANSTO-ARI	F0044-5A,5B,5C	Building 23 – High Activity LRT Unloading Facility
ANSTO- ARI	F0044-5A,5B,5C	ARI Facilities

INSPECTION REPORTS ISSUED

Licensee	Report number	Inspection
Australian Customs Service	R07/04829	Sydney Gateway Facility, NSW
CSIRO Land and Water	R08/01947	Black Mountain, Canberra, ACT
Defence	R08/01467	Woomera Waste Storage Facility, SA
Defence	R08/02604	RAAF Edinburgh Waste Storage Facility
Defence	R08/00891	Derwent Barracks, Hobart, TAS
ANU, Research School of Physical Sciences and Eng.	R08/01594	Acton Campus, Canberra, ACT
CSIRO Forest Biosciences	R08/00856	Hobart, TAS

LICENCE APPLICATIONS

Licensee	Licence Number	Type
Department of Health and Ageing, Mersey Hospital, TAS	A0191	Source – mobile medical fluoroscopy unit
Australian War Memorial	A0194	Source – Class 4 laser
ARPANSA Medical Radiation Branch, Yallambie, VIC	A0195	Facility – medical linear accelerator
Department of Foreign Affairs and Trade, Canberra, ACT	A0196	Source – portable handheld X-ray units, and Ni-63 itemisers

REGULATION 51 REQUESTS FOR APPROVAL

Licensee	Number	Type	Comment
Australian War Memorial	S0080	Source	Request for approval of relocation of radiation store
ANSTO-ARI	F0044-5A,5B,5C	Facility	Change to Building 54 shielded pipe work
ANSTO-WOTD	F0044-WOTD	Facility	Building 27 crane rail extension
ANSTO - OPAL reactor	FO0157	Facility	Delayed Neutron Activation Analysis Irradiated Target Storage Station - Addition of the target storage station
ANSTO - OPAL reactor	FO0157	Facility	Change to OLC Allowable values for RPO Low Water Level Trips
ANSTO - OPAL reactor	FO0157	Facility	Change to OLC 3.3.4 PAM Indication of Diesel Generator ON

REGULATION 51 APPROVALS

Licensee	Number	Type	Comment
ANU, Research School of Physical Sciences and Engineering	S0027	Source	Changes to X-ray micro-tomography laboratory
ANU, Research School of Earth Sciences	S0027	Source	Addition of UV sources to licence
ANU, Research School of Astronomy and Astrophysics	S0027	Source	Addition of UV sources to licence
ANSTO, OPAL Reactor, Delayed Neutron Activation Analysis Irradiated Target Storage Station	FO0157	Facility	Addition of the target storage station
ANSTO, OPAL Reactor	FO0157	Facility	Delayed Neutron Activation Analysis Irradiated Target Storage Station - Addition of the target storage station

Licensee	Number	Type	Comment
ANSTO, OPAL Reactor	FO0157	Facility	Change to OLC Allowable values for RPO Low Water Level Trips
ANSTO, OPAL Reactor	FO0157	Facility	Change to OLC 3.3.4 PAM Indication of Diesel Generator ON

TRANSPORT OF RADIOACTIVE MATERIAL

The CEO of ARPANSA, as the competent authority under the Code of Practice for the Safe Transport of Radioactive Material for transport of radioactive material by road and rail, approved a shipment of nuclear fuel from Sydney Airport to ANSTO.

Report on the operations of the Radiation Health and Safety Advisory Council, the Radiation Health Committee and the Nuclear Safety Committee

Radiation Health and Safety Advisory Council

The Council did not meet during the quarter. The next meeting is scheduled to be held on 11 April 2008 in Adelaide.

Radiation Health Committee

The Radiation Health Committee met 12 - 13 March 2008 at ARPANSA's Yallambie offices. A summary of the meeting is available at www.arpansa.gov.au/AboutUs/Committees/rhcmt.cfm. Key issues are discussed below.

FURTHER DEVELOPMENT OF THE NATIONAL DIRECTORY FOR RADIATION PROTECTION

The Radiation Health Committee (RHC) agreed that the next revision of the National Directory for Radiation Protection (NDRP) would proceed on the basis of individual proposals, similar in format to Statutory Rules used to amend regulations. The Committee agreed that the NDRP would be available on the ARPANSA website in this format. The endorsement of the Australian Health Ministers' Advisory Council (AHMAC) of the inclusion in the NDRP of those Codes and Standards published since NDRP Edition 1 will be sought out-of-session.

SOLARIA

A draft statement, in a form suitable for regulatory adoption, has been developed from the outcomes of the *National Forum on the Impacts of Regulating Solaria*. The AHMAC had endorsed the forum outcomes in March 2008 and the endorsement of the Australian Health Ministers' Council will be sought in April 2008. The Committee was informed that Victoria is in the process of appointing a consultant to prepare a Regulatory Impact Statement (RIS) and will consult with ARPANSA to determine how to prepare a RIS that will meet national requirements. The Committee was advised that South Australia had introduced solaria regulations in February 2008 and that Western Australia was proceeding with developing regulations that were consistent with the national approach. The Committee agreed that ARPANSA would organise the development of a simple training course and assessment, which was available on the internet, to demonstrate the competency of solarium staff. The Committee decided to write to the Australian Health Protection Committee suggesting the need for a nationally consistent approach to public health messages on solaria use.

CODE OF PRACTICE FOR RADIATION PROTECTION IN THE MEDICAL APPLICATIONS OF IONIZING RADIATION

The Committee considered a final draft of the medical code of practice and the final regulatory impact statement, which had been cleared by the Office of Best Practice Regulation. The Committee approved the draft code of practice for publication and recommended that the CEO forward the draft to the Radiation Health and Safety Advisory Council for its recommendation on adoption. The Committee also considered the revised draft *Safety Guide for Radiation Protection in Diagnostic and Interventional Radiology*. The Committee suggested several minor editorials to the draft and requested that a revised draft be

circulated to members out-of-session for final comment and approval. Members of the Royal Australian and New Zealand College of Radiologists (RANZCR) attended the meeting and briefed the Committee on the RANZCR's Quality and Accreditation Program. The Committee noted that the implementation of some requirements of the proposed medical code of practice may overlap with some elements required by the RANZCR Standards and decided that a small group, comprising members of the Committee, the RANZCR and ARPANSA, should be organised to discuss implementation issues.

The Committee considered a first draft of a code of practice that dealt with radiation protection in chiropractic radiology. The Committee requested that a revised draft, with editorial corrections suggested by members at the meeting, be prepared for the July 2008 meeting.

DEVELOPMENT OF THE RADIATION PROTECTION STANDARD FOR EXPOSURE LIMITS TO ELECTRIC AND MAGNETIC FIELDS 0 HZ - 3 KHZ

The Committee considered the issues and outcomes of the forum on the development of the Standard, which was held on 27 February 2008 with members of the working group for the Standard, consultative group for the Standard, the Committee and the electrical power industry. The Committee was advised that presentations from the forum are available on ARPANSA's web site at www.arpansa.gov.au/News/Events/elf.cfm and that a summary of the forum outcomes will available on ARPANSA's web site soon. The Committee was informed that a near-final draft, which had been revised in response to issues raised in the public comment process and at the joint meeting, will be presented for discussion by the Committee at the July 2008 meeting and circulated to the consultative group, along with the final regulatory impact statement and the working group's responses to public submissions.

OTHER MATTERS

Other matters considered were:

- a transport safety guide;
- the proposal for a revision of Radiation Protection Series No 1 in the light of the publication of new Recommendations by ICRP;
- a draft safety guide for the management of NORM in Australia;
- a national scheme for the classification of radioactive waste; and
- implementation of the COAG review of hazardous radioactive sources.

Nuclear Safety Committee

The Nuclear Safety Committee (NSC) met on 25 January 2008 at ARPANSA's Miranda office and 21 February 2008 at ARPANSA's Yallambie office. The Melbourne meeting was preceded by a tour of the Australian Synchrotron on 20 February 2008. Summaries of the meetings are available at www.arpansa.gov.au/AboutUs/Committees/nscmt.cfm.

The purpose of the extraordinary January meeting was to brief the Committee on the OPAL reactor displaced fuel plate event that occurred in July 2007. The CEO had asked members to consider three aspects of the process. In particular, the root cause analysis of the incident; the

modified design of the fuel; and the need to consider any changes to existing operational licence conditions.

Members were provided with background information on the incident and the ANSTO application by ARPANSA staff during the meeting. It was intended that the NSC discussion of the three aspects of the event would help inform the CEO in his decision making process.

During the 21 February 2008 meeting, the Committee received an update on the progress on the displaced fuel event. ARPANSA had raised several detailed questions with ANSTO relating to the event and it was expected that NSC would be asked to comment on the ANSTO responses following the meeting. Similar to the January meeting, the CEO sought the Committee's discussion of the issues during this meeting to help formulate his decision on the matter.

Reports required by subsections 60 (2)-(5) of the Act

Details of directions given by the Minister under Section 16

No directions were given by the Minister under Section 16 of the ARPANS Act during the quarter.

Details of any breach of licence conditions by a licensee during the quarter, of which the CEO is aware

BREACHES DETERMINED BY THE CEO

Licensee	Number	Nature of breach	Action
Department of Foreign Affairs and Trade	S0079	s31 of ARPANS Act – possession of unlicensed portable hand held X-ray units and Ni-63 itemisers	Application made to rectify the breach. No enforcement action necessary
Australian War Memorial	S0080	s31 of ARPANS Act- possession of unlicensed Class 4 laser	Application made to rectify the breach. No enforcement action necessary

Reports to the CEO from the RHSAC and NSC (paragraphs 20(f) and 26(1)(d) of the Act)

No directions were given by the Minister under Section 16 of the Act during the quarter.

A list of all facilities licensed under Part 5 of the *ARPANS Act*

ISSUED OR AMENDED LICENCES

Licensee	Number	Type	Comment
CSIRO Food Science Australia	S0023	Source	Schedule 1 of S0023 amended to include items from S0182 following a merger of the licences, and S0182 was surrendered
ANU, Research School of Physical Sciences and Engineering	S0027	Source	Schedule 1 of S0027 amended to include RF induction heater
Australian Customs Service	S0092	Source	Schedule 1 of S0092 amended to include industrial radiography

Licensee	Number	Type	Comment
Attorney General's Department, D Branch	S0188	Source	Schedule 1 amended to include dealings with portable handheld X-ray units
ASC Pty Ltd	S0190	Source – industrial radiography	New licence

Annex – Service Operations

1 Radiofrequency Calibration Laboratory

Calibration Requests	Jobs completed as NATA accredited reports	Job composition
75	67	49 monitors (with 34 probes) 26 personal monitors

2 Ultraviolet Protection Factor Testing, Licensing and Labelling

Job requests	Fabric samples tested	UPF trademark licenses completed	UPF swing tags issued	Pairs of sunglasses tested
59	213	19	531,000	7

3 Radioanalytical Service

Water	Food	Soil/Sediment	Filter	Wipe test
255	31	12	88	82

Maypacks	Biota	Other
0	0	25

4 Dosimetry Calibration Services

Therapy reference dosemeters	Electrometers	Standard ionization chambers	Gamma survey meters	Neutron survey meters	Personal dosimeters	Reference beams from sources or generators	Jobs in progress
9	7	-	-	4	4	1	3

5 Import Permits issued under Customs (Prohibited Import) Regulations 1956 – Medical Radioisotopes

Total permits issued	Single-shipment permits issued	12-monthly permits issued	Permits issued urgently
182	171	7	4

6 Import Permits issued under Customs (Prohibited Import) Regulations 1956 – Non- Medical Radioisotopes

Total permits issued	Single-shipment permits issued	12-monthly permits issued	Permits issued urgently
127	123	4	97

7 Export Permits under Customs (Prohibited Export) Regulations 1958

Total Permits Issued	0

Report to Parliament of The CEO Of ARPANSA under Section 61 of the Australian Radiation Protection and Nuclear Safety Act 1998 (The Act)

Decision on application for modified design of reactor fuel for the Open Pool Australian Light-water (OPAL) reactor.

1. Decision

Having considered all the material before me:

I find that the modification of the design of the fuel assemblies intended for use in the OPAL reactor proposed by Australian Nuclear Science and Technology Organisation (ANSTO) and detailed in its submission E0083 can be carried out safely and without undue risk to the health and safety of people and the environment. Therefore I approve the modification of the design of the fuel assemblies intended for use in the OPAL reactor under section 30(2) of the *Australian Radiation Protection and Nuclear Safety Act 1998* and Regulation 51 of the Australian Radiation Protection and Nuclear Safety Regulations 1999.

The approval for modification of the design of fuel is limited to fuel assemblies manufactured by CERCA

ANSTO may load the modified fuel into the OPAL reactor in conformity with the first stage of the return to service program that has been developed by ANSTO for this purpose and undertake testing consistent with this stage of the RTS program.

The existing authorisation under the facility licence authorising ANSTO to operate the OPAL reactor covers the proposed activities under the return to service program and there is no requirement for me to exercise my powers under section 36(1) of the *Australian Radiation Protection and Nuclear Safety Act 1998* to modify the authorisation granted under the facility licence.

However, I am of the opinion that certain aspects of the reactor's operations require continued monitoring and assessment and I propose to exercise my powers under paragraph 36(2)(a) of the *Australian Radiation Protection and Nuclear Safety Act 1998* to impose the following licence conditions on the facility licence that authorises ANSTO to operate the OPAL Reactor:

ANSTO shall, within six months of the date of imposition of the licence condition, develop a program of work, for review and approval by the CEO of ARPANSA, to characterise more fully the vibrational and other forces acting on the fuel plates and other structures in the core, the program to involve experimental work and theoretical calculation.

ANSTO shall complete a review of the design of the modified fuel assemblies within 2 years of the date of imposition of this licence condition in the light of the outcome of the work program required by the above licence condition and having regard to international best practice in nuclear safety.

ANSTO shall amend the specification for the fuel to be manufactured by CERCA to include the carrying out of the test of longitudinal strength, described in OPAL-0109-TRP-011 once per at least 20 Fuel Assemblies. Acceptance of the fuel must require a measured longitudinal strength greater than 27 N/mm.

Before exercising my powers under paragraph 36(2)(a) of the *Australian Radiation Protection and Nuclear Safety Act 1998* to impose additional licence conditions, I will allow ANSTO 28 days from the date of this decision to make any submission it may wish on this matter.

John Loy
CEO of ARPANSA

1 May 2008

2. Reaching the decision

2.1 INTRODUCTION

On 21 December 2007, I received a submission from ANSTO (E0083 – Fuel Assembly Design Modification to Incorporate a Stopper) seeking my approval to:

- modify the OPAL fuel design
- operate the OPAL reactor using fuel manufactured or modified[1] to that design.

ANSTO's request to modify the OPAL fuel assembly design and to operate the OPAL reactor using fuel manufactured or modified to that design arises out of ANSTO's analysis of the cause of fuel plate displacements that had been detected during the commissioning of the reactor. The fuel displacement event ("the event") is described in section 3.1.

While the event did not result in damage to the fuel and consequent exposures of workers or the public to radiation, the failure of the fuel in this manner was completely unanticipated. Such a failure was not analysed as part of the safety case for construction or operation of the reactor. Thus, while there were no radiological consequences as a result of the event, it was a serious matter that required very careful analysis and response.

ANSTO's requests for my approval are requests under the licence condition imposed by Regulation 51 of the Australian Radiation Protection and Nuclear Safety Regulations 1999 (ARPANS Regulations) for prior approval to make 'relevant changes' 'having significant implications for safety'.

In addition to assessing and making a decision on whether to approve the 'relevant changes' proposed, I also considered whether the issues raised by the occurrence of the fuel plate displacement and the analysis of the root cause of the displacement means that I should take action under section 36 of the *Australian Radiation Protection and Nuclear Safety Act 1998* (ARPANS Act) to amend the OPAL reactor operating licence.

2.2 THE REGULATORY BASIS

On 14 July 2006, I issued a facility licence under the ARPANS Act that authorises the ANSTO to operate the OPAL reactor. The licence defines to 'operate' as:

i) To operate the OPAL reactor for the purpose of hot commissioning, in accordance with the program defined in:

- Commissioning Plan
- Stage B1 Commissioning Plan
- Stage B2 Commissioning Plan
- Stage C Commissioning Plan; and

1 There are a number of matters that would need to be clarified before I could contemplate an approval that extended to the modification of existing CERCA fuel assemblies. Therefore this assessment and decision is confined to the manufacture of new CERCA fuel based upon the modified design.

ii) To operate the OPAL reactor for the purposes defined in the Application, in accordance with that Application.

Section 30(2) of the ARPANSA Act states that:

> *The holder of a facility licence must comply with conditions of licence.*

Division 4 of the ARPANS Regulations imposes a number of licence conditions applicable to all licences issued under the ARPANS Act. Regulation 51 of the ARPANS Regulations 1999 imposes a licence condition on all ARPANSA licences requiring:

> *The holder of a licence must seek the CEO's prior approval to make a relevant change that will have significant implications for safety.*

The Regulations define a 'relevant change' for the purposes of regulation 51 as being a change to:

> *(a) the details in the application for the licence; or*
>
> *(b) a modification of the source or facility mentioned in the licence.*

ANSTO's application for the facility licence to operate the OPAL reactor included extensive information about the detailed design of the fuel assemblies to be used in the OPAL reactor, including in particular in the Safety Analysis Report that supported the application for a facility licence authorising operation. Consequently, ANSTO's proposal to re-design the fuel assemblies to be used in the OPAL reactor is clearly a modification to the facility as defined in the scope of the original facility licence.

Given the fundamental significance of the nuclear fuel to the safety of the reactor, being the first barrier against release of radioactivity, it is clear that any modification of the fuel has significant implications for nuclear safety.

Therefore, operation of the reactor with fuel manufactured in accordance with the revised design or with fuel modified in accordance with the revised design involves changes to the details in the application for the licence and my approval for such a change must be granted before it can be effected.

In making my decision to issue the facility licence to operate the OPAL reactor, I assessed the safety of the design and construction of the systems, structures and components important for safety against the matters the legislation requires that I take into account and reached the conclusion that these were acceptable. It is now evident, as a result of the fuel plate displacement, that the design process was deficient with regard to the design of the fuel assemblies and that the fuel plates were not subject to a sufficiently effective safety analysis. (I discuss this issue further in section 5 of this statement.).

In addition to assessing and making a decision on whether to approve the relevant changes proposed, I also need to consider whether the circumstances of this request give rise to the need for me to exercise my powers under section 36 of the ARPANS Act.

Section 36 of the ARPANS Act provides:

> *The CEO may, at any time, by notice in writing given to the licence holder, amend the licence*
>
> *Without limiting subsection (1), the CEO may:*
>
> *(a) Impose additional licence conditions; or*
>
> *(b) Remove or vary licence conditions that were imposed by the CEO; or*
>
> *(c) Extend or reduce the authority granted by the licence.*

The type of amendment that may be required as a consequence of consideration of this submission includes consideration of whether or not the decision to allow ANSTO to recommence operation of the OPAL reactor requires an amendment to the authorisation for operation of the OPAL reactor granted under the facility licence; and whether or not I should impose additional licence conditions on that facility licence.

If I were to exercise my powers under section 36 of the ARPANS Act, Section 40 of the Act allows for review of licence decisions, including those made under section 36, first by the Minister and then by the Administrative Appeals Tribunal.

2.3 MATERIAL BEFORE ME

In making my decision, I have had regard to the legislative requirements of the ARPANS Act and all the material before me, including:

1. The ANSTO submission E0083 which included:
   - Analyses of the fuel displacement event ('Event theme' documents E0-E46) and conclusions as to the root causes of the event
   - Descriptions and analyses of the modified fuel design ('Design theme' documents D0-D39)
   - 'Submission' documents (S0-S6) including an executive summary (S1)
2. Questions ARPANSA posed to ANSTO provided in my letter of 15 February 2008.
3. ANSTO's responses (letters dated 14, 26 and 28 March) to my letter of 15 February including answers to the questions posed by ARPANSA, and additional documents and further testing and analysis that ANSTO had carried out in response to ARPANSA's questions.
4. The analysis conducted by Mr Horoschun as Consultant to ARPANSA, ANSTO's response and his review of that response. This analysis is discussed in the relevant parts of this statement.
5. A report prepared by Mr Jim Snelgrove, a consultant to ARPANSA, who reviewed ANSTO's original submission. A summary of his conclusions is at Appendix 1 of this statement.

6. Discussions of the Nuclear Safety Committee at meetings on 25 January and 21 February as documented in summary minutes of those meetings available on the ARPANSA website.

7. Responses from several members of the Nuclear Safety Committee after circulating ANSTO's responses to the ARPANSA questions to the Committee. This response is at Appendix 2.

8. The memorandum of advice on the submission prepared by ARPANSA staff and the briefings I received from ARPANSA staff throughout the review process on the status of their review and the formulation of questions to ANSTO and responses from the external experts.

3. The Fuel Displacement Event

3.1 DESCRIPTION

In July 2007, at the completion of cycle 5 of the OPAL fuel management cycle, the reactor had been shut down to prepare for cycle 6. Three fuel assemblies were removed from the core[2], another three were moved into different locations and three fresh assemblies were installed. Prior to the reactor being started up for cycle 6, the core was examined by camera to assure that the fuel movements had been carried out properly. At that point it was observed that a fuel plate was displaced from its position in a fuel assembly.

ANSTO took steps to ensure that the reactor was in a safe condition and to unload and examine the fuel assemblies in the core. These are described in document S1. The examination showed that several fuel plates had, in fact, been displaced. ANSTO also advised ARPANSA of the event.

Document E0 of the ANSTO submission presents details of the displaced fuel plates as follows:

FA	Date loaded	Number of cycles	Displacement
ARS 011	15/6/07	1	Plate 5=~530mm, plates 10,11,12
ARS 013	15/6/07	1	Plate 14=~370mm
ARS 012	15/6/07	1	Plate 14=25mm, plate 16=5mm
ARS 008	15/5/07	2	Plate 14=15mm
ARS 006	10/2/07	4	Plate 14=5mm, plate 12=<3mm
ARS 004	10/2/07	4	Plate 14=3mm, plate16=3mm
ARS 009	15/5/07	2	Plate 16=3mm

2 The OPAL nuclear core comprises 16 fuel assemblies, each assembly being constructed of 21 fuel plates that contain the uranium fuel. After each fuel cycle (approximately one month of operation), the core is changed with some burnt fuel assemblies being replaced by fresh ones and changes in the position of some assemblies. This process is undertaken to maintain the reactivity of the core within design parameters.

There were two fuel plates (no 5 in fuel assembly ARS 011 and no 14 in ARS 013) that were displaced by a substantial fraction of their total length (655 mm). This displacement took place in one cycle of operation. Another three to five plates had moved by noticeable amounts (14 in ARS 012, 14 in ARS 008 and 10, 11 and/or 12 under the handling pin in ARS 011 at least one of which had moved close to 65 mm preventing access by the handling hook). The other 5 plates had moved slight amounts.

Subsequent to the fuel displacement event, a review by ANSTO of previous examinations, of the core, including video footage of the core established that Plate 14 in ARS008 had moved slightly in cycle 4. It had then undergone further movement in cycle 5.

There had been 26 fuel assemblies irradiated at the time of the event – 13 were of two forms of 'start-up' fuel assemblies with lesser quantities of fissionable uranium and 13 'standard' fuel assemblies. All the displaced plates were in 'standard' fuel assemblies. In each standard fuel assembly, there are cadmium wires inserted adjacent to every second fuel plate, acting as a 'burnable poison'. Eleven of the displaced plates were in positions with the cadmium wires.

All the fuel used in the reactor up to the time of the fuel displacement event had been manufactured by the Argentinean company 'CNEA'. ANSTO had also entered a contract with the French fuel manufacturing company 'CERCA' for standard fuel assemblies, but these had not been used in the reactor by the end of cycle 5.

3.2 ANSTO'S SUBMISSION ON THE CAUSE OF THE DISPLACEMENT EVENT

I received ANSTO's submission in relation to the fuel displacement event (E0083) on 21 December 2007. ANSTO submitted that the root causes of the displacement of fuel plates were that:

- there was a flaw in the design of the fuel assemblies used in the reactor in that fuel plates were not restrained from upward movement by any kind of mechanical stopper.

The OPAL fuel assemblies have two aluminium side-plates with grooves into which the fuel plates are inserted and held by the process of swaging[3]. The grooves need to run out to one end of the side-plate to allow the fuel plates to be inserted during the fuel manufacture. The original design of the fuel assemblies had these grooves stopping above the top of the fuel plate. During design development, the side-plate was inverted so that the end with the grooves running out was now at the top above the fuel plates. ANSTO submits that the decision to invert the fuel assemblies was made in order to increase the strength of the attachment of the fuel assembly to the end box.

- the swaging process carried out by the fuel manufacturer CNEA did not produce a consistent and reliable joint with the sought after strength in the longitudinal direction.

ANSTO closely examined the CNEA swaging process and provided a detailed description and analysis of its potential to produce an inconsistent outcome. Longitudinal pull-tests carried out on some CNEA fuel assemblies demonstrated that the resistance in the

3 Swaging is a manufacturing process where two parts are fitted loosely together and then one part is mechanically deformed cold to create a permanent joint. In the manufacture of the OPAL fuel the joint between the side-plate and the fuel plate in the side-plate groove is 'roll swaged' by a wheel that deforms the side-plate to the immediate side of the groove.

longitudinal direction was much lower than the lateral pull strength and below the strength specified and assumed for the safety analysis report. The swaging strength for plates with cadmium wires was less than for plates without wires. ANSTO's examination of the two plates with the largest displacements revealed variation in the amount of plastic deformation on the plate surface, and in some cases almost no deformation

- the normal operation of the reactor

ANSTO submitted that the drag resulting from normal flow of water at the rate of over 8 metres/second past the fuel plates and vibrational forces, together with differential thermal expansion, in combination with the inadequate swaging of the fuel plates and the lack of a mechanical stopper acting as a barrier to fuel movement caused the fuel plates to move.

To support this view, ANSTO presented data on the operation of the reactor during the 5 fuel cycles and measurements of vibration undertaken at the fuel clamps and a number of measurements taken on dummy fuel assemblies in a flow loop in Argentina.

ANSTO did not carry out direct measurements of vibration within the OPAL core. The fundamental reason offered for not doing so was that having measuring devices installed in the core would perturb the coolant flow to the point where results would be unrepresentative of the undisturbed core. There are also some safety reasons for not doing this work and the radiation fields would also affect the measurements. ANSTO verified that the vibrational pattern in the control rod guide box fastener above the core was the same as had been measured in 2006, offering some assurance that there had been no change in overall vibrational patterns in the reactor.

3.3 ARPANSA QUESTIONS

In my letter of 15 February to ANSTO, referred to above, I accepted that a contributory cause of the event was that the original design of the fuel did not have any secondary stopping mechanism, relying entirely on the strength of the swaging. I also accepted that a second cause was that the swaging process for the CNEA fuel used in the reactor was deficient.

My letter focussed on the third factor ANSTO had identified as a cause of the fuel displacement in their root cause analysis. ANSTO submitted that it was the normal operation of the reactor working on the inadequately swaged fuel plates that, in the absence of a secondary stopping mechanism, caused the displacement of the fuel plates. In my letter I wrote that:

> *I need to be fully satisfied that there were no 'abnormal' operating circumstances that may have triggered the movement. You would appreciate that if there were 'abnormal' circumstances present, they could occur again in the operation of the reactor and that there may be other safety consequences. I need to understand more fully the pattern of vibration affecting the fuel plates and within the core generally. ANSTO has undertaken some studies in this regard, but I have a number of questions as to the extent and applicability of these studies.*

I provided ANSTO with a report from an external consultant to ARPANSA (Mr Gerhard Horoschun) who had carried out some analyses that indicated that, under certain assumptions about the clamping of the plates, the flow rate of the coolant between the fuel plates may be

approaching the 'critical velocity' at which point there would be hydrodynamic instability and the potential for collapse of the plates.

My detailed questions to ANSTO also covered:

- whether the measured longitudinal strength of the swaging of the CNEA plates – even though lower than required - when compared with the lower drag force calculated as applying to the plates indicated that other forces must be working on the plates and have caused them to be displaced
- the analysis of the location of the fuel assemblies with displaced fuel plates within the reactor core and of events and maintenance that may have caused the displacement
- analysis of vibrations in the fuel assemblies
- ANSTO's inspection regime for the fuel assemblies.

3.4 ANSTO RESPONSES

In its response of 28 March, ANSTO stated:

> *In summary:*
>
> - *no evidence of abnormal vibration has been found;*
> - *the core-flow distribution has been retested, and there is no significant change in that distribution since Stage A commissioning;*
> - *detailed analysis of the operating records show no unusual events during cycles 4 and 5;*
> - *the fact that relatively few plates moved suggests that there was no gross disturbance during the cycle;*
> - *the displaced fuel plates show no visual indications of damage or deformation; and*
> - there are no indications of damage or deformation to other reactor core structures and components.
>
> *The only identified force capable of displacing fuel plates is the drag force from coolant flow. Differential thermal expansion between the fuel plates and side plates produces a stress in the swaged joints. Additionally, normal vibrations present in the core contribute to a reduction in the restraining force within the joint. These two processes, combined with inadequate strength of the swaged joints between some fuel plates and side plates, leads to small relative movement along the joints. Once relative movement within the joint occurs, then the plates begin to displace under the influence of the drag force.*

ANSTO also stated that it had assessed relevant theoretical and experimental evidence and concluded that the major concern of Mr Horoschun with regard to critical velocity 'is not substantiated'. ANSTO provided a document that addressed the hydrodynamic stability of flat fuel plates of the type used in the OPAL fuel design and argued that it demonstrated that, at the flow velocities encountered in the reactor, there is considerable margin to the situation of hydrodynamic instabilities. ANSTO relied upon tests in the flow loop at high flow rates that

showed no damage to dummy fuel assemblies and that indicated that the critical velocity is not being approached. ARPANSA arranged for Mr Horoschun to review ANSTO's response and the supporting paper. His response is discussed below.

In response to my questions, ANSTO provided an analysis of the displaced fuel plates and any correlation with coolant flow, primary coolant system pump combination, fuel location, number of cycles in the reactor, plate power and temperature, fuel type, fuel orientation and fuel assembly sequence. ANSTO responded that only 'standard' fuel assemblies were affected. ANSTO observed that the fact that there were no displacements from fuel assemblies in the central parts of the core may arise from the fact that these locations only contained non-standard assemblies during the relevant period. No other correlations appear obvious, though later numbered fuel assemblies have the worse faults. The primary pumps B and C were in operation during cycle 5 compared with cycles 1-4 when pumps A and B operated, but there was no indication of any difference in coolant flows and pressures as a result.

ANSTO also provided further analysis of all events that occurred in cycles 4 and 5 and of maintenance activities. None of this analysis revealed any particular cause that could have contributed to the plate displacement.

3.5 ASSESSMENT OF THE CAUSE OF THE EVENT

Having reviewed the evidence, I conclude that the displacement of the fuel plates from the OPAL reactor fuel assemblies was a result of a combination of causes.

I find that there was a design flaw in the fuel assembly in that there was no secondary stopper mechanism to prevent movement if a primary barrier (swaging) failed.

I also find, based on the evidence presented in the ANSTO submission, that the swaging of the fuel that had been used in the reactor up to and including cycle 5 was inconsistent and did not have the strength expected of it.

These findings are consistent with the preliminary view that I expressed to ANSTO on 15 February 2008.

The final matter in relation to root causes of the event that arises for consideration is whether or not there was some abnormal operation of the reactor during cycle 5 (and cycle 4) that triggered the event or whether it was a combination of design flaws, inadequate swaging and the **normal** operation of the reactor (emphasis added).

ARPANSA expert, Mr Horoschun, raised issues related to the potential for the OPAL flow to be close to the critical velocity leading to significant instability. He reported after evaluating ANSTO's response that ANSTO had satisfied him that the vibrations of concern are 'extremely unlikely to be significant.' His discussion of the issues surrounding this matter satisfy me that there should be no fundamental concern about flow induced instability in properly manufactured OPAL fuel (including the operation of the leading-edge comb included in the fuel design). His discussions also lead me to emphasise the continuing importance of effective swaging for safe operation of the fuel assemblies. Continued testing of the swaging during the manufacturing process is essential.

ANSTO presented an extensive examination of the performance of the reactor over the 5 cycles, with particular emphasis on cycles 4 and 5 in which plates were displaced. This examination identified no evidence of any abnormal forces operating that would have caused the fuel plate displacements. The evidence presented by ANSTO of the vibrational forces within the core and operating on the fuel plates was indirect, in that they did not carry out in-core measurements in OPAL, but does not indicate that these forces were likely to be damaging to the fuel. ANSTO submitted that the most likely conclusion was that the normal vibrational forces and differential heating caused the joint between the fuel plate and side-plate to be weakened sufficiently to allow the known drag forces to displace the fuel plates.

Given the data available from the time preceding the incident, further review effort is unlikely to provide further explanation. Whilst ANSTO did not make direct measurements of the vibrational forces acting upon the fuel plates within the OPAL core, it has set out the reasons why this was not done. I accept the broad validity of those reasons and the questions that they would raise over the value of any data obtained. I also accept that the measurements of vibrations, taken on the dummy fuel assembly in the flow loop in Argentina, are reasonably indicative of the status of the operating environment of the fuel in OPAL.

The obvious question is ‘why cycle 5?’ It is the case that the largest movements occurred in two fuel assemblies loaded for the first time in cycle 5 and it may be that these were particularly deficient in the effectiveness of the swaging. But other plates did move, and there is the evidence of movement in cycle 4. So there is no simple answer to that question. But, ANSTO has carried out, a thorough examination of the operation of the reactor including undertaking additional testing after questions on these issues were raised by ARPANSA. There is no identified anomaly in this operation that would be a causal factor for the movement of the plates. Consequently, I find that the drag force is sufficient to displace the plates if the swaging is ineffective and that there is no evidence of abnormal operation of the reactor.

While it would have been desirable, if it were possible, to have direct measurements of the vibrational forces acting on the fuel plates during the operation of OPAL, the evidence from the direct measurements that have been done in other parts of the reactor circuit, when combined with the measurements undertaken in the flow loop, do not suggest that there were destructive forces operating in OPAL.

Taking all these matters into account, therefore, I am satisfied that allowing the reactor to operate again (with the modified fuel assemblies) does not present an unacceptable risk to the health and safety of people and to the environment.

Nonetheless, in view of the anticipated reactor operating life of (say) 40 years, I believe it would be appropriate for ANSTO to further develop its understanding of the vibrational forces acting on the fuel plates in the fuel assemblies within the reactor core. To this end, I am proposing an additional licence condition on the facility licence for OPAL that will require ANSTO to develop and implement a work program to address these issues.

4. The Proposed Modification to the Design of the Fuel Assemblies

4.1 DESCRIPTION

ANSTO is seeking my approval to modify the design of the OPAL reactor fuel assemblies according to a design that incorporates two aluminium stoppers screwed with two peened screws to the side plates of the fuel assemblies and positioned with the handling pin of the fuel assembly.

Further, ANSTO proposes that the modified design of the fuel assemblies would be manufactured by the French fuel company CERCA consistent with CERCA processes and quality management of their swaging process.

ANSTO stated that the design bases for the proposed modification are:

- to prevent vertical movement of 19 internal fuel plates greater than 3.5 mm without endangering the integrity of the fuel cladding;
- to ensure that there are no adverse effects on the structural, thermal-hydraulic, neutronic safety or performance of the fuel assemblies or any other part of the reactor; and
- to allow the modification to be made to existing un-irradiated fuel assemblies manufactured by CERCA.

4.2 ANSTO'S SUBMISSION ON THE DESIGN OF THE MODIFIED FUEL

In its submission ANSTO described the specification of the stopper and the fixing screws and its method of installation. ANSTO provided:

- a stress analysis of the stopper plate with a bounding assessment based upon the scenario of the impact of all 19 inner fuel plates on a single stopper plate supported by a single screw
- a neutronic assessment that demonstrated only a small 'reactivity worth' for a fuel plate displaced by 3.5 mm that would be allowed by the stopper.
- a thermal hydraulic assessment that examined the effects of the stoppers on coolant flow and the pressure drop across the core. This identified that there may be a small change in pressure drop – this will need to be measured when the reactor is returned to power as the pressure drop is a trip parameter for the first shutdown system
- an analysis of the coolant flow effects of plates being displaced by the maximum amounts allowed by the stoppers.

The ANSTO submission also discussed the stoppers and how they might affect fuel handling and final fuel disposition and submitted that there was no significant impact.

ANSTO reported the results of tests to a modified dummy fuel assembly (using natural uranium in place of the fuel meat) carried out in the flow loop in Argentina. This fuel assembly was constructed with 7 fuel plates being fully swaged; 2 fuel plates with swaging above the fuel plate only; and 12 unswaged plates. The tests, carried out with a flow rate of 116% of the normal OPAL flow rate for periods of 10 hours, then 230 hours and 33 days,

showed that the stoppers successfully prevented further movement of the unswaged fuel plates, which were displaced as expected.

Measurements of vibration of the dummy fuel assembly were undertaken and did not reveal any unexpected pattern.

Finally, the ANSTO submission provided a 'failure modes and effects' analysis of the stopper plates and screws during normal and abnormal operations.

ANSTO provided me with its specification for the fuel assemblies to be manufactured by CERCA to the modified design. As part of its overall submission, ANSTO described the fuel swaging processes and testing procedures adopted by CERCA and submitted that these would produce a more reliably swaged joint between the fuel plates and side-plates.

ANSTO also advised that:

- its fuel inspection regime will be improved
- all future fuel assemblies manufactured for use in OPAL will have detailed inspections undertaken by ANSTO at the point of manufacture. The process to be used for this inspection will be consistent with inspection methods currently used by a well established research reactor using similar fuel, HFR-Petten
- the OPAL fuel specification will be modified so that individual fuel plate pull tests are conducted similar to those conducted for HFR-Petten. For the OPAL tests, 7 of the 21 plates in a test sample will be pulled from the side-frame in the lateral direction to determine those individual fuel plates swaging strength

ANSTO provided a statement of the conclusions of its international advisory committee that it had commissioned to review the proposed modification to the fuel assembly. The conclusions of the advisory committee with respect to the design of the stopper were that:

- *The proposed stopper is considered to be a solution to prevent fuel plates' displacement;*
- *The postulated failure of the stopper needs to be assessed in view of the existing SAR and PSA;*
- *The stopper is positioned 3.5 mm above fuel plates;*
- *The stopper is mounted with two screws (4 mm length); tack welding could be considered as an additional securing method;*
- *Reducing width of the empty side plate slot beyond the end of the fuel plates should be considered ("secondary stopper");*
- *Some of the alternative designs of the stopper (pins, combs, etc.) will influence the results and validity of hydraulic testing already performed;*
- *If needed, these alternatives can be considered in due time;*
- *Modifying the side plate slots might be the long term solution.*

4.3 ARPANSA QUESTIONS

In my letter of 15 February 2008 to ANSTO, I said that the second major issue that needed to be clarified was effectiveness of the proposed design of the stopper and the manufacture, quality assurance and inspection of the fuel. I forwarded some 22 questions relating to the design to modify the fuel assembly and 9 questions on manufacture, quality assurance and inspection.

Issues covered in the questions included:

- the validity of the comparisons between the flow loop tests carried out on dummy fuel assemblies with natural uranium meat and flow tests using the aluminium dummy fuel assemblies used in OPAL commissioning on the one hand and the flow for real OPAL fuel on the other
- the stress analysis calculations for the stopper screws
- the effectiveness of the peening operations used to secure the stopper screws
- the analysis of the hydraulic and dynamic forces acting on the stoppers and screws
- the rigour and extent of the flow loop testing of the fuel with the modified design
- the stopper screw design
- the process for mechanical testing of swaged joints in the lateral and longitudinal direction
- the process proposed by ANSTO for enhanced end-of-cycle inspections of fuel

4.4 ANSTO RESPONSES

In its responses of 26 and 28 March 2008, ANSTO stated that it had carried out a number of further tests to support its submission on the structural integrity of the stoppers and screws.

It stated that:

> *The conclusions of the tests and further information from manufacturers confirm that:*
>
> - *the screws that attach the stopper plate to the FA side plate are able to fulfil this function under all normal operational conditions. A number of M6x9 slotted-head screws were tested to determine the failure load under simulated and in-service installation conditions. The failure torque was measured to be approximately twice the installation/service torque;*
> - *the stopper plates are able, individually, to withstand the loads imposed by the impact of all 19 fuel plates without plastic deformation;*
> - *the stopper plates are able, individually, to withstand the loads imposed by the fuel plates caused by fluid drag and hydraulic loads imposed on them by the coolant flow, without plastic deformation;*
> - *peening of the screws increases the torque required to loosen those screws and provides continuing resistance to rotation;*
> - *calculations show that fatigue is not likely to occur in the stopper plates or the attachment screws, even if they were to become loose; and*

- *although the screws do not comply with all the requirements of AS/NZS 1427, the differences have no effect on the ability of the screws to perform their intended function.*

The further ANSTO submission was centred on a report from ANSTO's Institute of Materials Engineering. This report provided a static and dynamic analysis of the stopper plate screws, tests of the effectiveness of peening and an analysis of the structural integrity of the stopper plates. ANSTO submitted calculations showing that the stresses in the stopper screws arising from the force exerted by 19 fuel plates were well within the yield-strength of the screws. A physical test was also carried out that directly simulated the impact of the side-plate being simultaneously struck by 19 fuel plates moving under the drag force of the flow. ANSTO submitted that the examination of the stopper plates after this test showed that no permanent plastic deformation was caused by this impact.

With regard to manufacturing, inspection and quality assurance issues, ANSTO supplied additional information on the CERCA roll swaging process.

ANSTO submitted that it had confidence in the CERCA roll swaging on the following grounds:

- *it uses a computer controlled and repeatable process*
- *both sides of the fuel plate are secured and swaged simultaneously*
- *the process is supported by a parametric study of key roll-swaging parameters*
- *CERCA is an industrial facility with an output of 350 elements per year and has experience with numerous complex fuel designs that operate under onerous conditions including FRM II and ILL.*

ANSTO further described the longitudinal pull test that had been carried out on a CERCA fuel assembly that indicated that the longitudinal strength of the CERCA swaging was consistent with its strength in the lateral direction and well in exceedance of the longitudinal strength measured for the CNEA fuel. Subsequently, ANSTO provided the results of another four tests of the longitudinal strength of CERCA fuel, which showed similarly satisfactory results. It did not propose ongoing longitudinal testing as a routine on the grounds of advice from fuel manufacturers that standardised longitudinal tests and criteria are neither established nor accepted internationally.

4.5 ASSESSMENT OF DESIGN AND MANUFACTURING ISSUES

While not explicitly stated in its original submission, the subsequent ANSTO responses have made it clear that it is relying upon:

- the swaging undertaken by CERCA as being the primary barrier to upwards movement of the fuel plates
- the stopper mechanism as being an effective secondary barrier to movement.

With regard to the reliance on swaging as a primary defence, I am aware that there is no internationally accepted longitudinal strength testing procedure. Before swaging could be given credit as a primary mechanism for preventing movement of the fuel plates, there needs to be measurement of the effectiveness of such swaging. The results of tests carried out on

CERCA fuel to date satisfy me that the appropriately swaged fuel is constrained because of that swaging and this gives me confidence in the CERCA fuel already manufactured to the new design. On this basis, I accept that it is appropriate for ANSTO to present swaging as a means of preventing movement, with the stopper being a secondary mechanism. However, if swaging is to be relied upon for the future, a longitudinal strength testing program needs to be continued and I propose to make a licence condition to this effect. I accept that there is no internationally established longitudinal strength test – but the tests that have been carried by CERCA seem thorough and effective. I propose that the acceptance criterion remain at the value of 27 N/mm that had been applied in the original safety case for OPAL.

With regard to the effectiveness of the stopper mechanism as proposed, a large number of ARPANSA questions strongly tested the design and challenged its effectiveness in the process of questioning. ANSTO responded by carrying out a good deal of additional testing and analysis. I accept that the results of the analyses satisfactorily address the issues surrounding the effectiveness of peening of the stopper screws. I also accept the calculations and testing of the stresses in the screws which shows that they remain within their yield strength under the impact of 19 fuel plates and the mechanical tests of the stopper plates showing no plastic deformation when struck by an equivalent force.

Having said that, it is likely that the design of the OPAL fuel could be improved, if addressed from first principles, without the constraint of needing to be able to modify existing fuel. This is particularly the case in the light of further knowledge of the vibration patterns affecting the fuel plates and knowledge of the effectiveness of swaging that will be accumulated over the next years. I propose to make it a licence condition that ANSTO review the design of the fuel within two years of this decision.

In the light of the fuel displacement having occurred, the possibility of ejection of fuel plates from the core needs to be analysed in the OPAL safety analysis report (SAR). This is common ground with ANSTO and needs to take place in the context of the revision of the SAR required by the operating licence.

5. Safety Management Issues

5.1 DESCRIPTION

I have accepted that a fundamental basis for the displacement event was a flaw in the design of the OPAL fuel assemblies that allowed the fuel plates to move vertically without a secondary stopper mechanism. As noted in section 3.2 above, the original design did not have this flaw – the grooves for insertion of the fuel plates were at the bottom of the assembly and they stopped above the fuel plates, preventing significant upwards vertical movement. During the finalisation of the design, the side-plates were inverted to allow for strengthened attachment of the fuel assemblies to the clamps which attach them to the coolant inlet.

The examination of the sequence of events shows that the designer INVAP did not consider the implications of the design change; it was not drawn to ANSTO's attention specifically, nor did ANSTO reviewers pick up on it as having any significance. This was also the case for ARPANSA review of the fuel assembly design during the process of giving approval to construct items important for safety under the facility licence that authorised construction of the OPAL reactor.

The issue is whether the oversight in the design review process for the fuel assemblies has any significant implications for the design review of the other OPAL systems, structures and components that are important for nuclear safety.

5.2 ANSTO'S SUBMISSION ABOUT SAFETY MANAGEMENT ISSUES

In its submission, ANSTO acknowledged the 'less than adequate design review' in this case. It stated that:

> *A risk assessment such as an FMEA was not conducted for the fuel assembly, as the established rules for such an analysis during the design phase of the RRR project indicated that FMEAs should be applied to Safety Category 1 systems and assemblies, not components. The fuel was considered to be a component under this system.*

It listed as one of the 'lessons learned' as a result of the incident:

> *To check that no other nuclear safety significant items require risk assessments a review of Safety Category 1 structures, systems and components will be undertaken as part of the safety case update program to identify if any items previously classified as passive components may in fact be considered assemblies of components.*

ANSTO subsequently submitted a document (OSR-010 dated 16 January 2008) that included a table of all the Safety Category 1 systems, structures and components and the risk assessments that had been performed. The document stated that all such structures, systems and components had been subject to a Failure Mode and Effect Analysis except in a small number of cases where ANSTO relied on other types of risk assessments associated with the particular structure, system or component.

The root cause analysis included with ANSTO's submission discussed the circumstances leading to the design oversight. Factors that it brought forward included that:

- Reputable fuel manufacturers accepted the design for tendering purposes without questioning it
- Roll swaging has had a long record of success in research reactor fuel
- It was assumed, in the absence of established longitudinal pull-out tests, that the strength of the swaged joints in that direction was the same as that indicated by lateral pull-out tests.

The document concluded:

> *Therefore it is inferred that whilst less than adequate design review of the FA design and manufacturing process is the root cause of the OPAL fuel fault, it was due to the specific circumstances outlined above. There is no indication of any systemic failure of the extensive design review process deployed in ANSTO for the OPAL Project.*

5.3 ARPANSA QUESTIONS ABOUT SAFETY MANAGEMENT ISSUES

ARPANSA asked six questions about the safety management implications of the event. The questions addressed the role of ANSTO and INVAP in the review of the modified design for the fuel assemblies in 2002. One ARPANSA question challenged the conclusion of the root cause analysis about the lack of any evidence of systemic failures in the design review

process. The question pointed to other matters that had emerged during the commissioning of the reactor being:

- A fire in the starter motor of a diesel generator arising from an inadequate grounding system and inappropriate maintenance surveillance of the generator batteries
- A flaw in the First Reactor Protection System interlocks that meant an operator in certain circumstances could bypass an interlock
- A failure of a diesel generator on a load test and a subsequent failure to start due to failure in the fuel injector
- Leaks in the reflector vessel that resulted in light water mixing with the heavy water in the reflector vessel.

5.4 ANSTO RESPONSE TO QUESTIONS

ANSTO again acknowledged that its design review process for the fuel had not been effective. It pointed to a focus on the issue of strengthening of the fuel-plate to end-box stability and the mindset that the swaging provided an effective means of avoiding any upwards movement of the fuel plates. It reiterated its position that it could find no evidence of a systemic failure in the design review process. For each of the events cited in the ARPANSA question, ANSTO responded that there had been different root causes, none were related to flaws in design review, being deficiencies in manufacture, installation or maintenance and a software error in one instance.

ANSTO submitted:

> *The conduct of a design review process does not always prevent component failures, although it is a major objective. In any complex engineering system, it is recognised that there will be some 'teething' troubles, which will be identified in its early life, particularly during commissioning, despite design reviews and quality assurance measures.*

5.5 ASSESSMENT OF SAFETY MANAGEMENT ISSUES

Having assessed the evidence, I conclude that the design review oversight that did not assess the implications of the change of design that resulted in the side-plate grooves being at the top of the fuel assembly flowed from a mind-set of the reviewers that swaging was accepted as a barrier of more than adequate strength to prevent upwards movement of the fuel plates. Thus, the design change was not thought to be of significance and not brought to attention as an issue with significant implications for safety by INVAP to ANSTO and in turn by ANSTO to ARPANSA. This resulted in the design change not being the subject of detailed scrutiny by any of these parties.

The ARPANSA reviewers, not having their attention drawn to this matter, focussed on other issues about the fuel.

I accept ANSTO's view that the several issues that have arisen during the OPAL commissioning are not necessarily of themselves indicative of flaws in the design review process overall. Each has a somewhat different cause and it is the purpose of a commissioning and early operating period to ensure that early problems are detected and addressed.

The design and manufacture of fuel for research reactors is very specialised and expert knowledge of fuel design issues is not widespread in the research reactor community. Certainly the OPAL fuel has now been thoroughly tested and the work program that I propose to include as a new licence condition on the OPAL facility licence will further develop the knowledge of the performance of the fuel in its operating environment..

6. OPAL recommencement of operation with the modified fuel

6.1 OPAL RETURN TO SERVICE

Once the modified design of fuel is approved by me ANSTO has advised that that they wish to then return the reactor to service. I have been provided with a return to service plan by ANSTO.

It is ANSTO's submission that:

- this return to service plan is already contemplated by the scope of the authorisation given under the facility licence that authorises operation of the reactor.
- the Return to Service Program (RTS) does not involve a revision or a replacement of an evaluation methodology used in the SAR. It is stated that the test instructions are based on commissioning procedures as used during stage B1, B2 and C Commissioning Stages.
- there are no activities or tests that are to be performed that have not already been considered in the SAR or Commissioning Safety Case.
- the RTS program does not involve any change to the SAR, operational limits and conditions (OLCs), plans and arrangements for managing safety or plant procedures.

Based on the documents that I was provided with prior to making this decision, I am confident that I may allow the modified fuel to be loaded into the reactor and appropriate tests to be carried out for the completion of that stage.

I wish then for my regulatory inspectors to provide me with a report on the outcome of fuel loading. Whilst these activities are being undertaken I will review the remaining steps that are proposed in the RTS Program.

In summary ANSTO may:

- perform all activities associated with verification and surveillance of the OLCs undertaken in shutdown conditions.
- remove the 16 new fuel assemblies from the fresh fuel vault, inspect them in accordance with new instructions specifically developed for this purpose and load the fuel assemblies into the reactor pool storage rack.
- perform testing, including the measurement of core differential pressure with 16 fuel assemblies loaded into the core and with the reactor shutdown and for different primary coolant pumps configuration.
- undertake other preparatory testing and verification.

- transfer fuel assemblies from the storage rack to the core. This would correspond to the loading of the 12 first fuel assemblies. My approval would be required before undertaking the approach to criticality.

6.2 SCOPE OF THE AUTHORISATION

The key issue in relation to the scope of the authorisation is whether the return to service of the OPAL reactor is contemplated by the existing authorisation. As previously discussed this authorisation defines operation as being comprised of hot commissioning and then routine operation. At the time of the fuel displacement event the OPAL reactor had completed Stage C commissioning and had submitted a Stage C Commissioning report to me for my consideration. As at 26 July 2007 there were some outstanding issues that I wished ANSTO to address in the context of the Stage C commissioning report. These matters are still outstanding.

I characterise the return to service as a continuation of the hot commissioning program, particularly as the return to service requires a "start up" core. The tests and procedures that will define this stage are drawn from the commissioning tests and procedures and are clearly defined by ANSTO in its submissions as part of the commissioning stage. I am satisfied that it is within the existing envelope of the authorisation as I defined it when I issued the facility licence on 14 July 2006 and I therefore do not intend to amend the scope of the existing authorisation. I will deal with the staged return to service under the existing authorisation.

John Loy
CEO of ARPANSA

1 May 2008

Appendix 1

Summary Findings of Report from Mr Jim Snelgrove

Mr Snelgrove had worked for many years at the Argonne National Laboratories in the US on a program to produce reduced enrichment fuel for research reactors. He reviewed ANSTO's submission and reported in summary as follows:

On the basis of my review of all documents reviewed:

- *I find the ANSTO/INVAP investigations of the fuel-plate-movement events to be comprehensive, well-planned, well-executed, and well-documented.*
- *With the exception of the few errors noted in Section 3, I found the information presented in all of these documents to be accurate.*
- *I concur with the finding that a lack of adequate swaging and of a "stopper" allowed the plates to move. I emphasize, however, that the underlying causes were the lack of an adequate design and a less than adequate review of the FA design and manufacturing process.*
- *I concur with the proposed remedy of adding a stopper plate to each element side plate; this remedy has been verified to work both by analysis and experiment. In fact, the addition of the stopper plates slightly decreased the hydraulic resistance of the fuel element.*
- *The fuel element specifications presented contain all necessary information and are in accord with international best practice.*
- *I found no unresolved potential safety issues.*
- *In my opinion, ARPANSA would be justified to approve continued operation of OPAL using the proposed modified fuel elements, based upon the documentation that I reviewed.*

ANSTO has undertaken to correct the errors identified by Mr Snelgrove in its documentation.

Appendix 2

Comments from Nuclear Safety Committee members

Following circulation of the ANSTO responses to questions out of session to NSC members with a request for any comments, I received the following from Dr Peter Johnston:

> *I have examined the responses from ANSTO of March 2008 and these have satisfied me that they have undertaken reasonable and appropriate studies and reached sound conclusions.*
>
> *In particular:*
>
> *1. Root Cause Analysis (RCA)*
>
> *The RCA has 3 elements (i) no stopper (design flaw), (ii) swaging failure, and (iii) the fault occurred during routine operation.*
>
> *(i) The design flaw is clear and acknowledged.*
>
> *(ii) The deficiencies with CNEA swaging have been clearly demonstrated.*
>
> *(iii) To prove a nil result about abnormal occurrences is not possible, but the documentation indicates a clear search of appropriate areas has been conducted without finding a cause in an abnormal occurrence. I conclude the RCA is sound.*
>
> *2. Is the proposed new stopper and new CERCA fuel adequate?*
>
> *I believe the documentation about the adequacy of the stopper design, screws and possible deflection convincing. I am also convinced that the quality of CERCA swaging is superior to that of the original CNEA fuel and adequate.*
>
> *3. Is there evidence of systematic design failures in faults observed to date?*
>
> *No. There has been a good account of the nature of observed faults during commissioning and an underlying systematic trend is not evident. Research reactors such as OPAL are individually designed and therefore could be considered prototypes. Commissioning should bring forward faults as has occurred.*

4. Why did the fault occur in cycle 5 and not previously?

There is some evidence of minor plate movement in Cycle 4. Further analysis of FAs and plate numbers has not identified why cycle 5 was the cycle of failure. I cannot see any point in pursuing this point further.

5. Vibration Issues

ANSTO have provided valid reasons why further testing using accelerometers closer to FPs was not undertaken. I also find the arguments presented to be satisfactory with respect to critical velocity and vibration. The examination of irradiated plates, lack of wear marks as well as testing of dummy FAs provides evidence that vibration concerns are not substantiated.

6. ANSTO Safety Management

ANSTO has explained in more detail the process of internal committees dealing with the safety submission. The quality of documentation provided to support submission E0083 is much superior to that provided on previous occasions. The time taken by ANSTO in internal reviews and their extent indicate an improvement in safety culture and respect for regulatory process. While improving safety culture is an ongoing process, I view these improvements positively.

General Conclusion

I have no further questions about submission E0083 and I am happy to see it approved. I believe the state of the reactor following extended shutdown to be a separate matter.

Mr Neil McDonald and Professor Ian Polmear supported this general conclusion, though Professor Polmear would have preferred that the stopper be secured by rivets or by spot welds at an edge of the screws.