Overview

• Introduction
• Nuclear Status in Australia
• Australian Nuclear Science and Technology Organisation (ANSTO)
• LEU Mo-99 Production
• Spent Fuel Management Program
• Radioactive Waste Management
Nuclear Status in Australia

- Population: 24 million
- No nuclear power
- The Australian Nuclear Science and Technology Organisation (ANSTO) operates Australia’s only reactor
- Australia has 30% of the world’s uranium reserves and is world’s 3rd largest producer of uranium ore concentrate
- Nuclear power and Australia’s role in the nuclear fuel cycle is still being debated

Nuclear Industries and Operations in Australia

- Australia does not have a nuclear power industry; nuclear related activities/industries include:
  - Expanding uranium mining industry; three mines operating and a further three scheduled to begin production in the near future.
  - Seven cyclotrons for radiopharmaceutical production
  - Operation of a 20MW research reactor (OPAL) for radioisotope production, NTD Silicon and thermal/cold neutrons (ANSTO)
At the national level, there is bipartisan support for the ongoing operation of the Australian uranium industry, however the responsibility for licensing and regulating uranium exploration and mining lies with the states.

### World Uranium Reserves and Production

<table>
<thead>
<tr>
<th>Country</th>
<th>Reserves</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>29%</td>
<td>9%</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>13%</td>
<td>39%</td>
</tr>
<tr>
<td>Canada</td>
<td>9%</td>
<td>22%</td>
</tr>
</tbody>
</table>

### Australia’s Uranium Export Policy

- The policy limits the export of Australian uranium to countries that are a party to the Nuclear Non-Proliferation Treaty (NPT), have an Additional Protocol in force and are within Australia’s network of bilateral nuclear cooperation agreements.
- A list of countries to which uranium is exported in any one year is NOT made publicly available, but the list of countries with which Australia has bilateral nuclear cooperation agreements is here: [http://dfat.gov.au/international-relations/security/non-proliferation-disarmament-arms-control/policies-agreements-treaties/Pages/australias-network-of-nuclear-cooperation-agreements.aspx](http://dfat.gov.au/international-relations/security/non-proliferation-disarmament-arms-control/policies-agreements-treaties/Pages/australias-network-of-nuclear-cooperation-agreements.aspx)
Australia’s Position on Nuclear Power

- Australia’s present policy (2012 Energy White Paper), is that the Australian Government does not support the use of nuclear energy in Australia.
  - This stance is under active debate in view of climate change and the need to have a variety of means to produce a dependable base-load electricity supply (low carbon)
  - In the past 10 years there have been a number of high profile reports to the government making the case for introducing nuclear energy into Australia
  - In July 2013 The Academy of Technology Sciences and Engineering (ATSE) held a conference on this issue;
    - ‘nuclear power represents a "transformational opportunity" for the nation to reach its clean electricity goals while ensuring a reliable energy source’

South Australia Royal Commission – Nuclear Fuel Cycle

Established by the SA Government in 2015
Undertook an independent investigation into the potential for increasing SA’s participation in the nuclear fuel cycle including:
- Expanded exploration and mining of radioactive ores
- Further processing and manufacture from radioactive ores
- Electricity generation from nuclear fuels
- Management, storage and disposal of radioactive waste

Results were released May 2016
A Citizen’s Jury rejected the Commissions Report in early November
The SA Government released its response on 15 November 2016, supporting nine of the 12 recommendations in the Royal Commission’s report.
A summary of the SA Government response is available below:
ANSTO overview

- Formed in 1953
- HIFAR critical 1958
- >$1 billion assets under management
- Annual turnover > $350 million
- Circa 1200 employees; 300 Ph.D.’s
- OPAL Reactor Critical 2006

ANSTO - Landmark Scientific Infrastructure

- OPAL Research Reactor
- Accelerators
- Synchrotron
- Cyclotron
OPAL Research Reactor

20 MW Open Pool Australian Light water reactor
Light water cooled and moderated
Heavy water reflector
Compact core consisting of 16 fuel assemblies
Nuclear medicine, neutron science and silicon irradiation
Celebrating 10 years of operation

OPAL Operations

OPAL Operating Days at Power CY's (2006 - 2016)

Total Power Days

OPAL - Criticality 12 Aug 2006

High availability, high reliability
Australian Research Reactor History

HIFAR 1958-2007

MOATA 1961-1995

OPAL 2006 - Present

Strategic Research
Australia’s National Research Priorities

ANSTO Research Infrastructure

Research Themes

- Nuclear Science
- Environmental
- Brain Health
- Radiotracers and Radioisotopes
- Energy
- Resources

Isotope
t Tall Nati Sys

Nuclear Stewardship

- Nuclear Fuel Cycle
- Reactor
- Nuclear Facilities
- Isotope Facility

Advanced manufacturing

Cyber security

Transport

Energy

ANSTO Nuclear Medicine

- Fully operational 2017
- Mo-99 facility; 3,500 6 day Ci per week
- Proven, reliable, LEU-LEU technology
- Integrated operations with OPAL Reactor
- 25% of World Mo-99 demand
- World’s first full scale Synroc waste treatment plant

Synroc Waste Treatment Plant
LEU/LEU Mo-99

Production Process for Mo-99

LEU in reactor for irradiation & Mo-99 from fission process

Mo-99 separated

Intermediate Liquid Waste to be immobilized by Synroc process

Tc-99m Generator to Customer or Bulk
ANSTO Global Mo-99 Supply

<table>
<thead>
<tr>
<th>Bulk Mo-99</th>
<th>Tc-99m Generator</th>
<th>Mo-99 &amp; Tc-99m Generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>Singapore</td>
<td>China</td>
</tr>
<tr>
<td>Turkey</td>
<td>New Zealand</td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>Russia</td>
<td>Hong Kong</td>
</tr>
<tr>
<td>South Korea</td>
<td>Brazil</td>
<td>Philippines</td>
</tr>
<tr>
<td>South Africa</td>
<td>Taiwan</td>
<td>Myanmar</td>
</tr>
<tr>
<td></td>
<td>Vietnam</td>
<td>Indonesia</td>
</tr>
</tbody>
</table>

Spent Fuel Management
HIFAR Fuel (1958-2007)

- Various designs over 49 year life
- Composition: uranium aluminide
- Enrichment: 80-93% U-235 for more than 48 years
- Converted to LEU in 2006 before permanent shut-down in January, 2007

OPAL Fuel (2006-Present)

- Standard research reactor fuel of screwed & swaged construction
- Composition: uranium silicide dispersed in aluminium
- Enrichment: 19.8% U-235 (LEU)
- High burn-up (avg. 55%)
- High decay heat
- Consume 27-30 assemblies per year
Spent Fuel Management Timeline

  - 1960s to late 1970s, Australia planned to introduce nuclear power and develop a domestic reprocessing facility
  - On-site storage adopted

- **ANSTO (1987 – Present)**
  - No domestic reprocessing facility in Australia
  - Exploration of other options including disposal in the USA and reprocessing in the UK (commenced in late 1970s)
  - In 1997 the Australian Government announced construction of Replacement Research Reactor (OPAL), and approves reprocessing of ANSTO’s spent fuel at the La Hague facility, France ($A 88M)

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Wet & Dry Storage (HIFAR)

**Wet storage**

**Spent Fuel Transfer Flask**

**Dry Storage**
ANSTO Experience with Spent Fuel Shipments

- Managed 9 successful shipments of Spent Fuel to UK, France and USA between 1963 – 2009

INF2 Class Ship

- Maritime transport of Spent Fuel has to be undertaken in an INF2 ship as required by the International Maritime Organization (IMO)
  - meets mandatory INF code for international shipping of Nuclear Fuel, Plutonium and High-Level Radioactive waste packages
  - Special features which make it more robust in potential accident scenarios
  - Certified to carry irradiated nuclear fuel or high-level radioactive wastes with an aggregate radioactivity less than $2 \times 10^6$ TBq
**ANSTO Spent Fuel Shipments**

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>FA Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td>Dounreay</td>
<td>150 FA</td>
</tr>
<tr>
<td>1996</td>
<td>Dounreay</td>
<td>114 FA</td>
</tr>
<tr>
<td>1998</td>
<td>US SRS</td>
<td>240 FA</td>
</tr>
<tr>
<td>1999</td>
<td>COGEMA</td>
<td>308 FA</td>
</tr>
<tr>
<td>2001</td>
<td>COGEMA</td>
<td>360 FA</td>
</tr>
<tr>
<td>2003</td>
<td>COGEMA</td>
<td>344 FA</td>
</tr>
<tr>
<td>2004</td>
<td>COGEMA</td>
<td>276 FA</td>
</tr>
<tr>
<td>2006</td>
<td>US SRS</td>
<td>330 FA</td>
</tr>
<tr>
<td>2009</td>
<td>US SRS</td>
<td>159 FA</td>
</tr>
</tbody>
</table>

2281 SF assemblies in 9 shipments

ILW from reprocessing of 1288 HIFAR SF assemblies returned from France Dec 2015

**Spent Fuel Disposition**

**USA**
- Under FRRSNFA program - no waste returned to Australia

**Dounreay**
- Reprocessing wastes from 114 spent fuel assemblies;
- Cemented ILW
- Substitution for vitrified wastes now permitted
- Substitution enacted July 2014
- Return to Australia by 2020

**AREVA**
- Reprocessing wastes from 1288 spent fuel assemblies;
- Vitrified ILW
- Technological cemented ILW
- Returned to Australia in Dec 2015

Dec 2015 AREVA ILW Return
UK Waste Substitution
Substitution = Volume Reduction

51 x 500 L cement filled drums
25 500 L waste for disposal

4 x 170 L vitrified waste canisters
680 L waste for disposal

2.7% of cemented waste volume

On-site Storage OPAL Spent Fuel

Reactor Pool
Connected Service Pool
OPAL Reactor

Wet storage,
10 year capacity
OPAL Spent Fuel Management

- ANSTO has no legacy SF from HIFAR and MOATA Reactors
- ANSTO committed to responsible management of OPAL SF
- Government funding approved for reprocessing (overseas)
- In 2015 ANSTO entered into an agreement with AREVA, France for the transportation and reprocessing of OPAL SF
- AREVA has established capacity to reprocess silicide fuels
- Provides a simple, whole of life solution for OPAL spent fuel
- The first shipment to France is scheduled for 2018 with shipments every 7 years thereafter
- Vitrified ILW will be returned to Australia before 2040
AREVA TN-MTR Cask

Mass: 23 t
Height: 2 m
Diameter: 2 m

Operational Details - Shipments to France

- Shipping schedule:
  - 236 assemblies (4 casks) in 2018,
  - 186 assemblies (3 casks) in 2025, and
  - 186 assemblies (3 casks) every 6 or 7 years thereafter
- Ship all fuel uncropped
- Post-2030 waste return as ILW in TN-81 casks
- Two TN-81 casks of residues for OPAL lifetime
ILW Return from France - 2015

20 Canisters of Vitrified ILW

115 t AREVA TN-81 Cask

A long term communication campaign to inform the community

1 May 2012

6 December 2015

31 months
### Planning

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>March - April</td>
<td>April</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Planning</th>
<th>Pre-Announcement</th>
<th>Announcement</th>
<th>Ongoing Stakeholder engagement</th>
<th>Waste Return logistics</th>
<th>Ongoing Stakeholder engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Strategic documented plans to deal with each stakeholder group</td>
<td>Brief key local, state and federal MPs. Brief shadows &amp; local community stakeholders</td>
<td>Informing staff, local community, general public and media</td>
<td>Regulatory engagement, be responsive to media &amp; stakeholder needs</td>
<td>Communication and consultation is a key part of logistics planning</td>
<td>Reinforce ANSTO's position as interim storage</td>
</tr>
<tr>
<td>Ratted and endorsement internally and development of clear consistent messaging</td>
<td>Explain project - meaning for community, Aus, International community &amp; ANSTO</td>
<td>Australia is a responsible global citizen. We benefit and we understand the responsibility</td>
<td>ANSTO is capable of safely managing the waste on behalf of Australia. Remember we have enjoyed the benefits</td>
<td>ANSTO safely handles and transports nuclear materials every day</td>
<td>ANSTO is temporarily managing the waste for Australia</td>
</tr>
<tr>
<td>Identify and engage with select media and key politicians</td>
<td>ILW exclusive website increase ANSTO's profile</td>
<td>Assist Govt. in taking the lead on announcement</td>
<td>Reinforcing the established and proven benefits of nuclear. Safety of transportation internal case studies</td>
<td>Continuous and reassuring safety messages with stakeholders locally and nationally</td>
<td>Legislation prohibits ANSTO from being the national waste store for Australia</td>
</tr>
</tbody>
</table>

### Managing Reputation Risk

#### 2012

- Change of Government
- All levels of government clearly understand ANSTO’s role and the value it delivers
Interim Waste Store at ANSTO

- Australia does not yet have a National Radioactive Waste Management Facility
- Government requested ANSTO provide interim storage for ILW

October 2014 → November 2014 → April 2015

Managing stakeholder interest on arrival

- 115 radio stories, plus 859 syndications
- 48 online stories
- 26 stories in print, including two front page stories
- 64 television news stories, plus 427 syndications.
Radioactive Waste Management
The Future - National Radioactive Waste Management Facility

- More than 100 sites across Australia store LLW and ILW
- Sites are not suitable for long term storage
- Australian Government sought willing communities

- 6 short-listed sites
- April 2016 - provisional selection of Barndioota, South Australia
- Construction 2018 - 2020
Thank you