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Synroc for ILLW Mo-99 Waste Treatment

2013 Mo-99 Topical Meeting

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Outline

- Overview of ANSTO
- Mo-99 ILLW
- Why Synroc
- What is Synroc
- Economics of the Synroc process
- Key Advantages of the Technology
- Plant Design
- Concerns and Mitigations
- Delivery of the Synroc Plant

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What is ANSTO?

Landmark facilities for Australian science

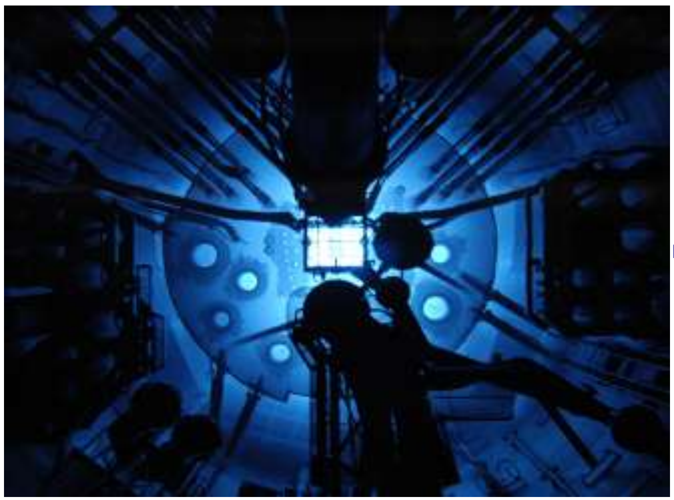





Lucas Heights • Clayton • Camperdown • Vienna

Production Process for Mo-99

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



Mo-99 separated

Tc-99m Generator to Customer or Bulk

ILL Waste immobilized in SYNROC process (Alkaline & Acidic)

Why has ANSTO chosen Synroc?

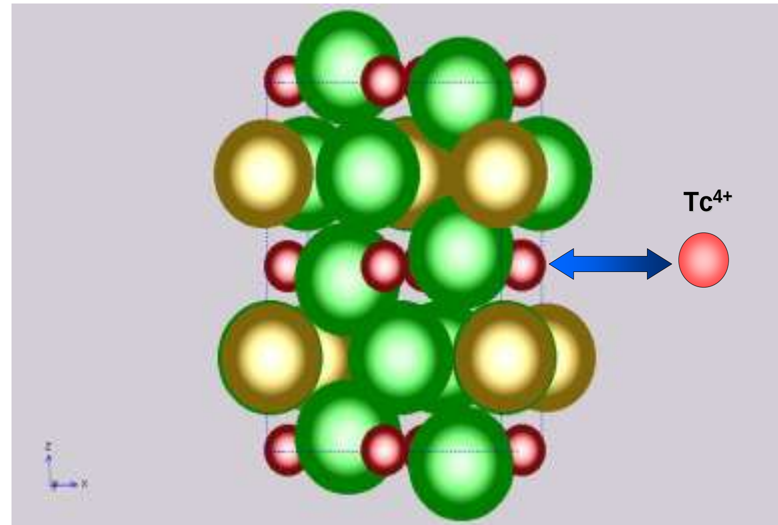
- Ability to meet future national radioactive waste store/ repository Waste acceptance criteria
- Meet regulatory safe guards requirement for Uranium waste streams
- Business Case showed that Synroc technology implementation not more expensive that other Technologies e.g. Cement, Vitrification or continued storage.
- Full life cycle costs considered; Treatment, Storage, Transport and Disposal
- Demonstration of the Synroc technology “First of Kind”

What is Synroc?

- Synroc (synthetic rock)
  - *Designed on naturally occurring minerals*
- A waste form concept (philosophy) for nuclear waste where radioisotopes incorporated into the crystal lattice of durable mineral phases.

- Taylor the additives to the waste chemistry

- Synroc used as a brand name for a family of Waste Form solutions including Ceramic, Glass-Ceramic & Metallic encapsulation.



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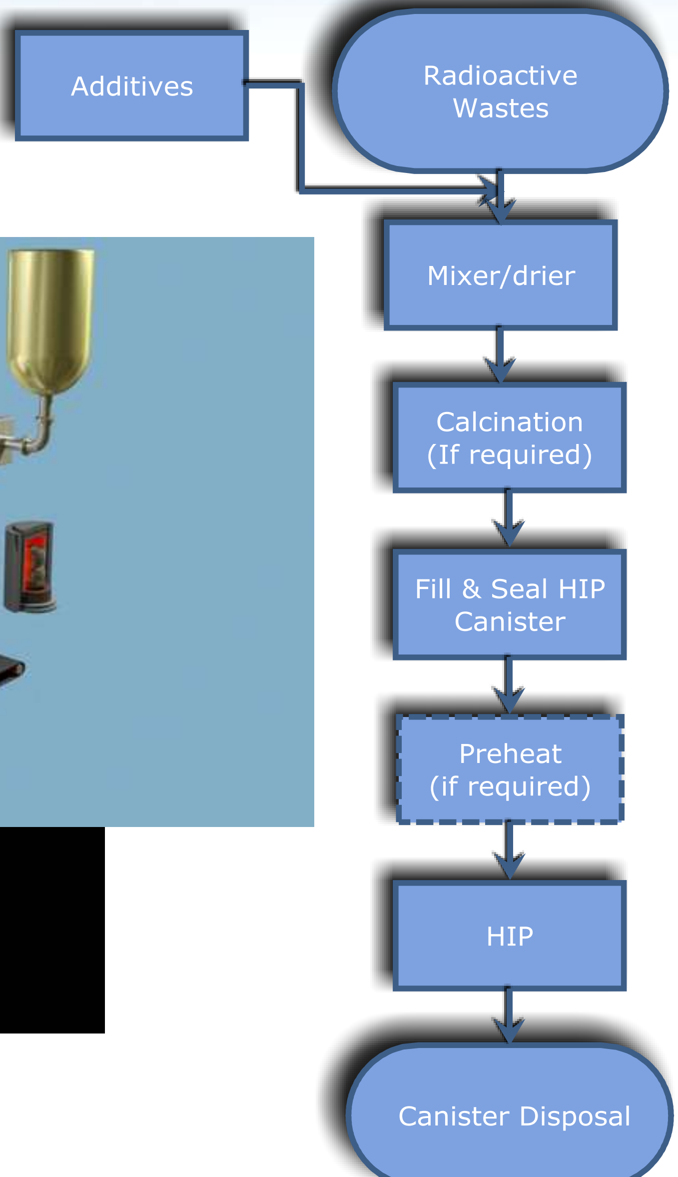
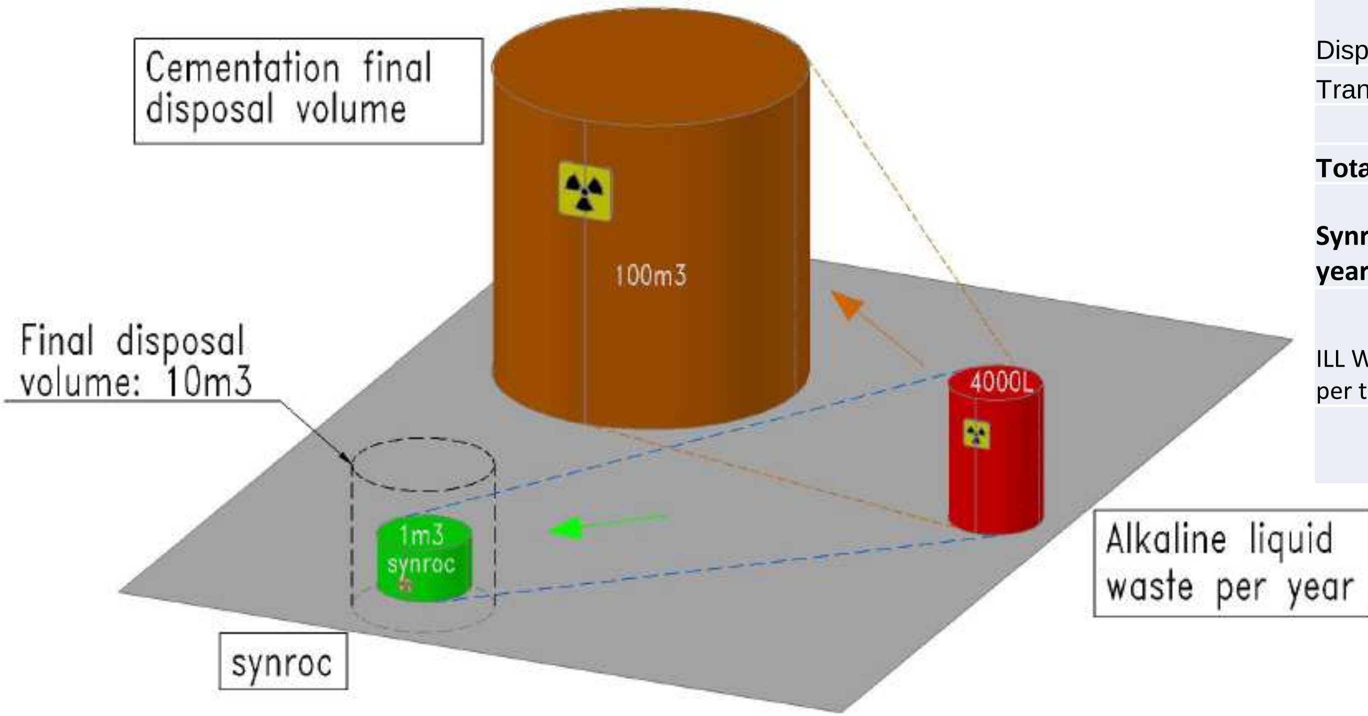
ANSTO Synroc HIP Treatment Technology



Storage Volumes of Treated Wastes



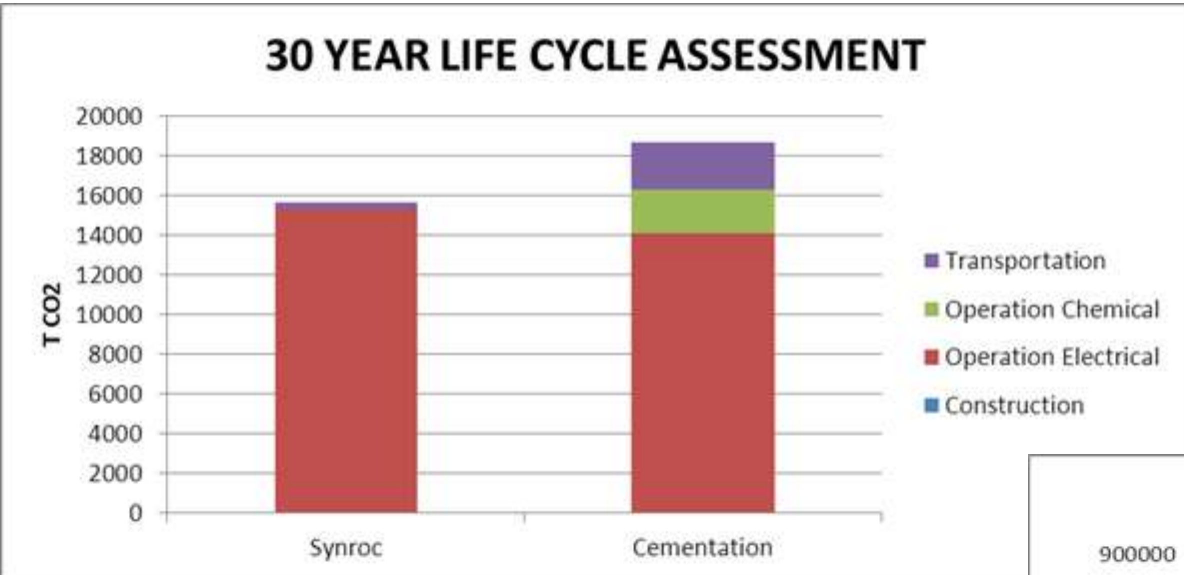
Yearly Costs	synroc	cement
Operational Cost	$3,081,664	$3,147,115
Depreciation cost	$3,525,000	$4,266,667
Disposal Costs	$1,246,684	$5,875,000
Transport costs	$249,337	$1,175,000
Total	**$8,102,686**	**$14,463,782**
Synroc option saves/ year	**$6,399,430**	
ILL Waste treatment cost per target plate (ANSTO)	$1,323	$1,485

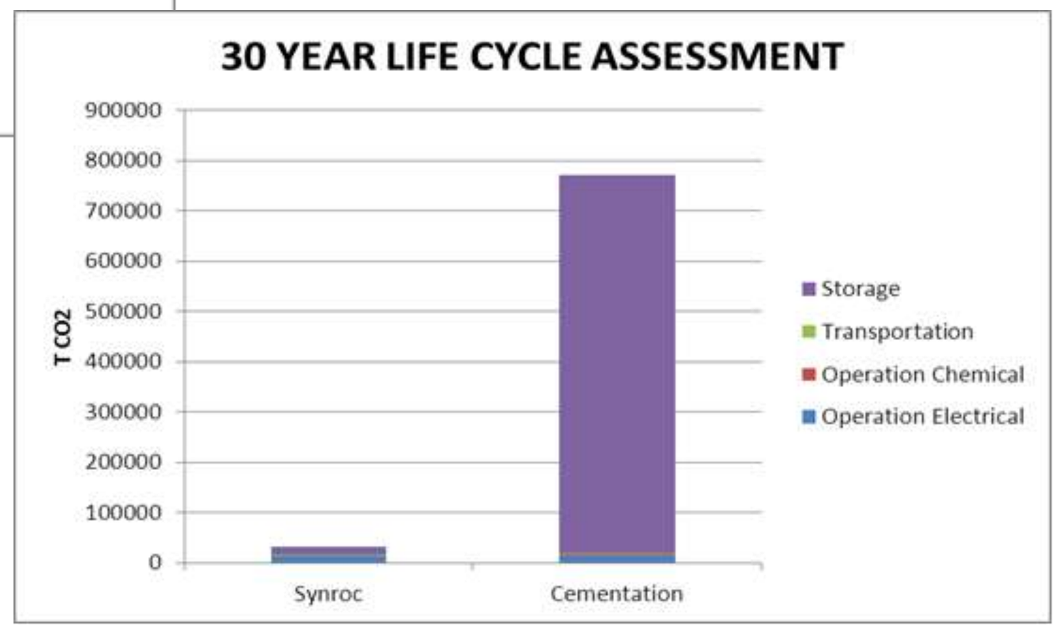
Disposal volume of waste

Cementation transport per 10 years
1560 Tonnes (> 150 trucks)

ANSTO Synroc® transport per 10 years
140 Tonnes

Full life cycle foot print



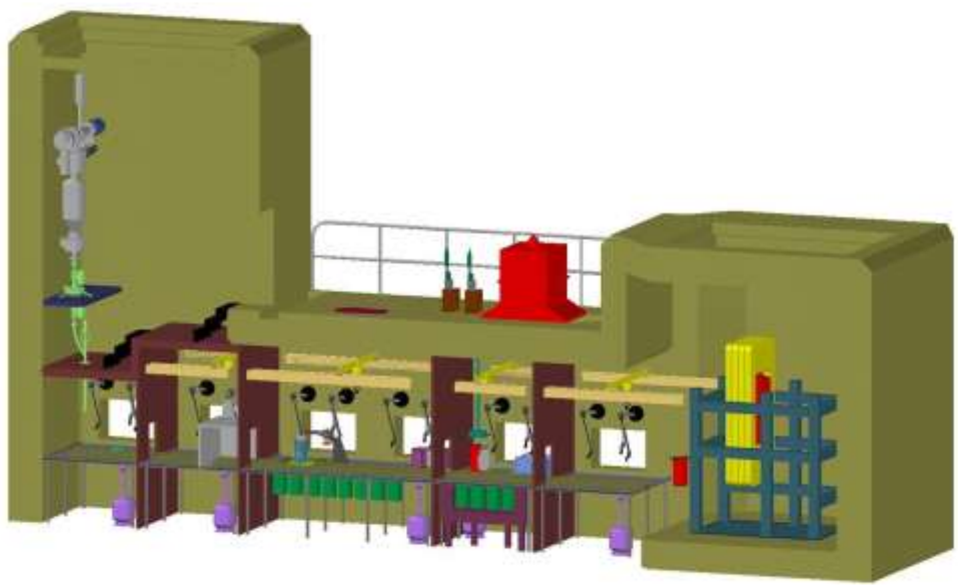


Plant and Process Design

- Conservative design to treat 6,000-7,000 l/year
- Can be ramped to near double that capacity
- Treat both Acidic (Uranium+ FP waste stream) & Alkaline wastes
- Could also treat low level waste if business case can be made
- Additional module could be added to the plant in the future to immobilise Uranium filter cake
  - Requires Business case and process demonstration

Plant and Process Design

- Addressed concerns:
  - The use of high pressure in a hot cell environment- HIP design “defence in depth”
  - The spread of contamination (Can Filling and powder processing)
  - HIP can failure leading to damage of the HIP and the release of radioactive material.
  - The scale up of the process (demonstrated from 0.5 to 200Kg)



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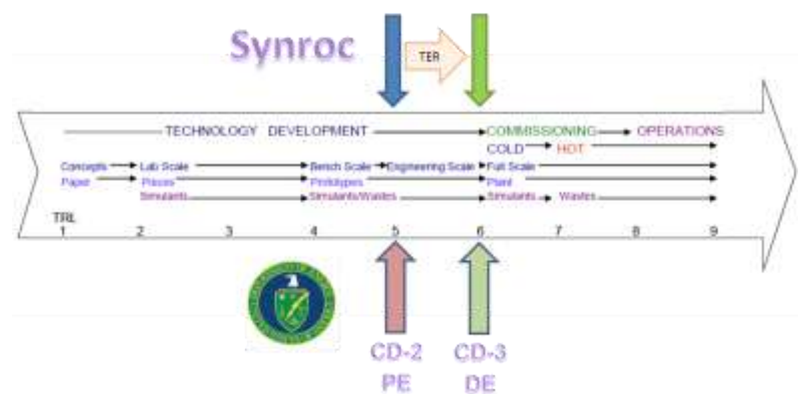
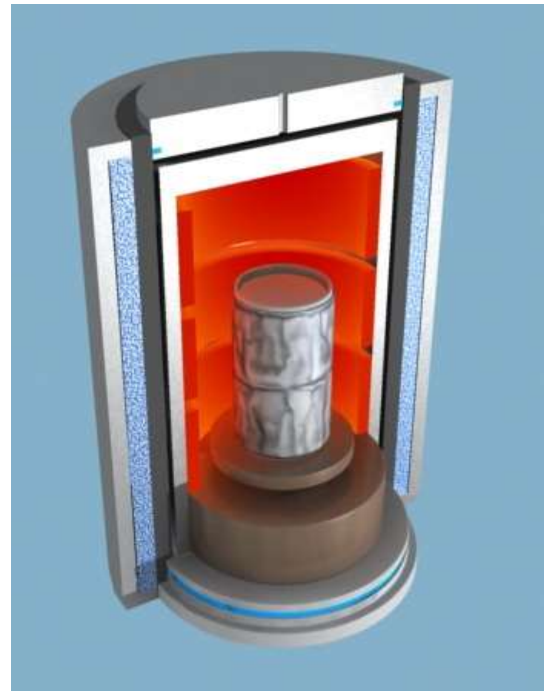
Scale Up

- Test equipment operated at 1/3 scale and technology readiness level for new technology assessed at a TRL 5/6
- Also Demonstrated HIP can at approx. 200kg scale
- Full scale mock-up testing will be completed by mid 2014



Project Delivery

- Planned to be Operational by Early 2016
- World first to use HIP technology for immobilisation of radioactive waste on production scale
- Full true life cycle costs for production of Mo-99 and treatment of waste



Key Advantages of the Process

- Maximising waste loadings to decrease waste volumes.
- Optimising chemical durability so that the waste form can meet regulatory requirements.
- Eliminating radioactive isotope off-gas emissions during consolidation process
  - Simplify the off gas system design and reduces secondary wastes.
- Process flexibility such that the system can readily cope with waste streams of variable chemistry.
- Providing the option to treat multiple waste streams in the one plant.
- The above benefits produce significant life cycle cost savings

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Nuclear-based science benefiting all Australians

HIP Design- high pressure in hot cell

- Conservative design code ASME Div. 2 or 3 (+ additional safety factor)
  - Leak before Burst, High cyclic life
- Custom developed control system
- Selection of existing and new materials of construction for radiation tolerance
- External cooling for criticality control, low coolant volume
- Intrinsically safe in the event of LCA- chosen an non pre-stressed forged Vessel (not wire wound)
- Full remote loading and unloading
- Hot Cell designed to mitigate against over pressurization

Contamination control

- Developed a can filling system that minimizes spread of radioactive powder

- Reduction of Secondary wastes:
  - Sealing system does not require crimping and cutting of fill tube
  - Waste does not come into contact with high temperature process (unlike vitrification)

- Process steps are compartmentalised allowing for an extremely clean process
  - ability to remove source term and allows man entry lowers cost in the design and maintenance

HIP Can Design

- Designed to collapse into near right cylinder (model closely matches actual)- maximising disposal canister utilisation
- Fail safe can design, limited expansion to prevent over pressurisation
- Active Containment Over-Pack(ACOP) prevents particulate spreading and mechanical restraint to protect furnace and pressure vessel
- Integrated use of ACOP resulting in lower costs for decommissioning and Maintenance costs