NTP Radioisotopes (Pty) Ltd

Conversion Experience Regarding Transition of ^{99}Mo Production from HEU to LEU in South Africa

G Ball

1st Annual Mo-99 Topical Meeting
Santa Fe, New Mexico, USA, 4-7 December 2011

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Outline

- Background
- Conversion Project
- Current Status
- Impact of Conversion
- Challenges
- Concluding Remarks

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Background

Map of South Africa

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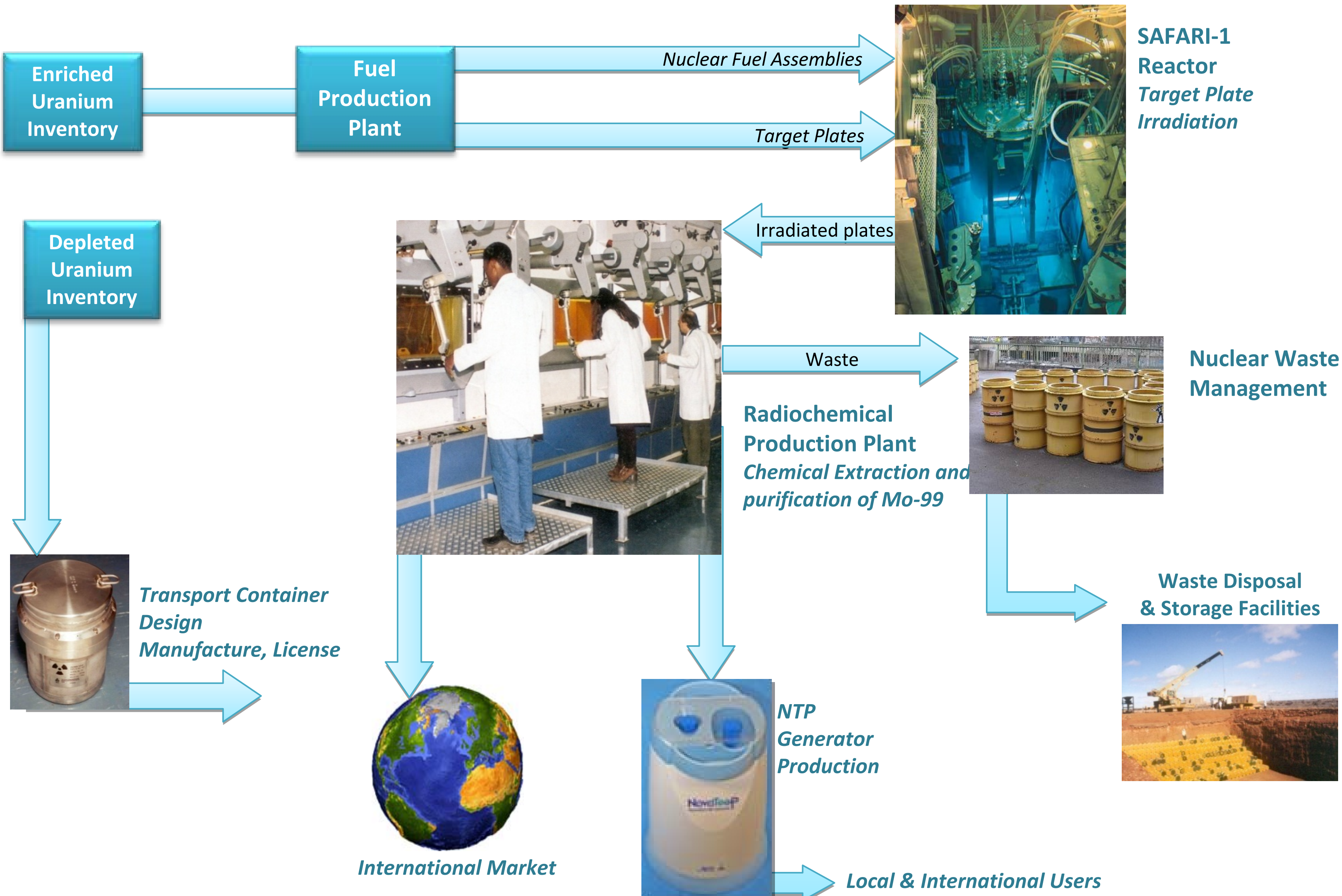
Established site at Pelindaba in the mid 1960s
Pelindaba is the Zulu word for “done talking”
Pelindaba site is 2 361 ha
140 Permanent Buildings on the site
Ecological reserve

Background


Enriched Uranium Inventory
Fuel Production Plant
Nuclear Fuel Assemblies
Target Plates
SAFARI-1 Reactor
Target Plate Irradiation
Irradiated plates
Depleted Uranium Inventory
Waste
Nuclear Waste Management
Radiochemical Production Plant
Chemical Extraction and purification of Mo-99
Transport Container Design
Manufacture, License
Waste Disposal & Storage Facilities
NTP Generator Production
International Market
Local & International Users

Background

- Development work on HEU process commenced in late 1980's
- First hot runs (20Ci) took place in 1992
- Tc99m generator tests performed in 1993
- First 100 Ci Mo99 runs performed in 1993
- First generators with NTP Mo99 sold in Q2 1994
- First 200Ci Mo99 runs performed in Q3 1994
- First export Mo99 sales in Q4 1994

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Background

- Pilot plant commissioned in 1992 but underwent various changes up to 1994
- New production line comes online in 1995
- Second production line comes online in 2000
- First production line upgraded in 2005
- Third production line under construction (Required due to conversion)

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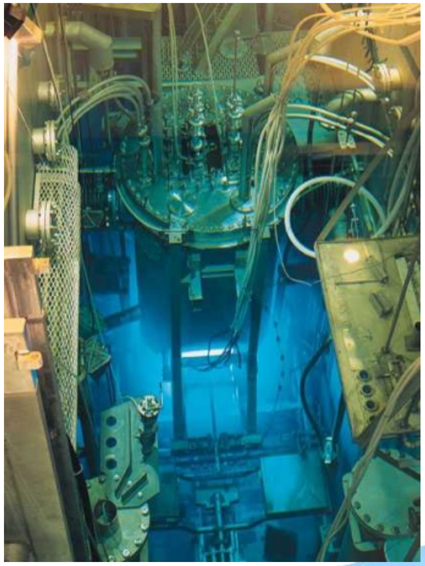
Conversion Project

Mo-99 Target Conversion Strategic Considerations

- **Minimum changes to target, irradiation, handling & chemical processes**
- **Retention of production capacity**
- **No interruption in current production**



Conversion Project

Conversion to LEU to take place in 2 phases:

Phase 1: Known target technology; minimum changes at reactor facilities; minimum process changes.

U-Al Dispersion target

Phase 2: New target; changes at reactor facilities and process; significant benefits

Probably higher density target; retrievable from clad

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Conversion Project

Parameter	LEU	HEU
Meat	Dispersion	Alloy
Enrichment	19.75%	45.0%
Uranium density (g.cm^{-3})	2.75	1.42
Dimensions (mm)	200/50/1.66	200/50/1.66
Cladding	Alloy	Pure aluminium
U-235 Loading	Maintain (or minimise decrease)	

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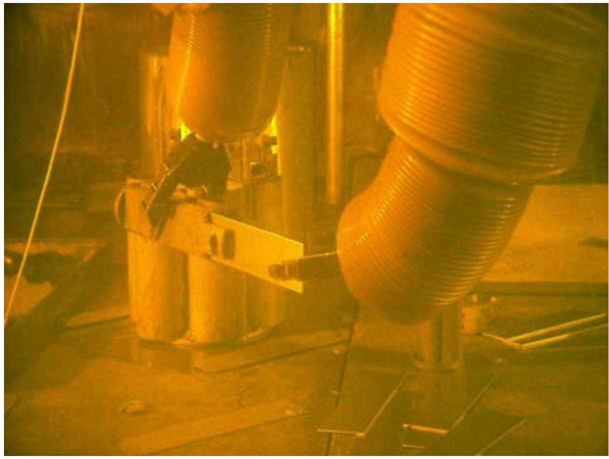
Conversion Project



- Theoretical feasibility studies
- Cold experiments on depleted uranium targets
- Test Irradiation Program in SAFARI-1
- Process development and tests on irradiated LEU targets
- Process validation
- Licensing approval process

Conversion Project

Year	Event
2007	Theoretical feasibility studies
2008	Cold and depleted uranium experiments
Oct 2009	NNR approval received for test stage and first hot runs commence
Mar/Apr 2010	Process validation runs performed
Jun 2010	Submission to NNR for routine LEU ^{99}Mo production Submission of DMF to Medical Regulators commenced
Jul 2010	Customer tests and validation runs commenced
Sep 2010	NNR approval received for routine operation with LEU
Sep 2010	US FDA approves LEU ^{99}Mo for a customer in the US
Dec 2010	First large scale commercial FDA approved batch of LEU ^{99}Mo produced and shipped to US for patient use
Jun 2011	Routine commercial supply of LEU ^{99}Mo commenced to some customers

Current Status

- Commercial supply to customers authorized to use LEU ^{99}Mo
- Supply of LEU ^{99}Mo to customers for testing/validation
- Significant investment in infrastructure (primarily due to significantly increased uranium residue volumes)

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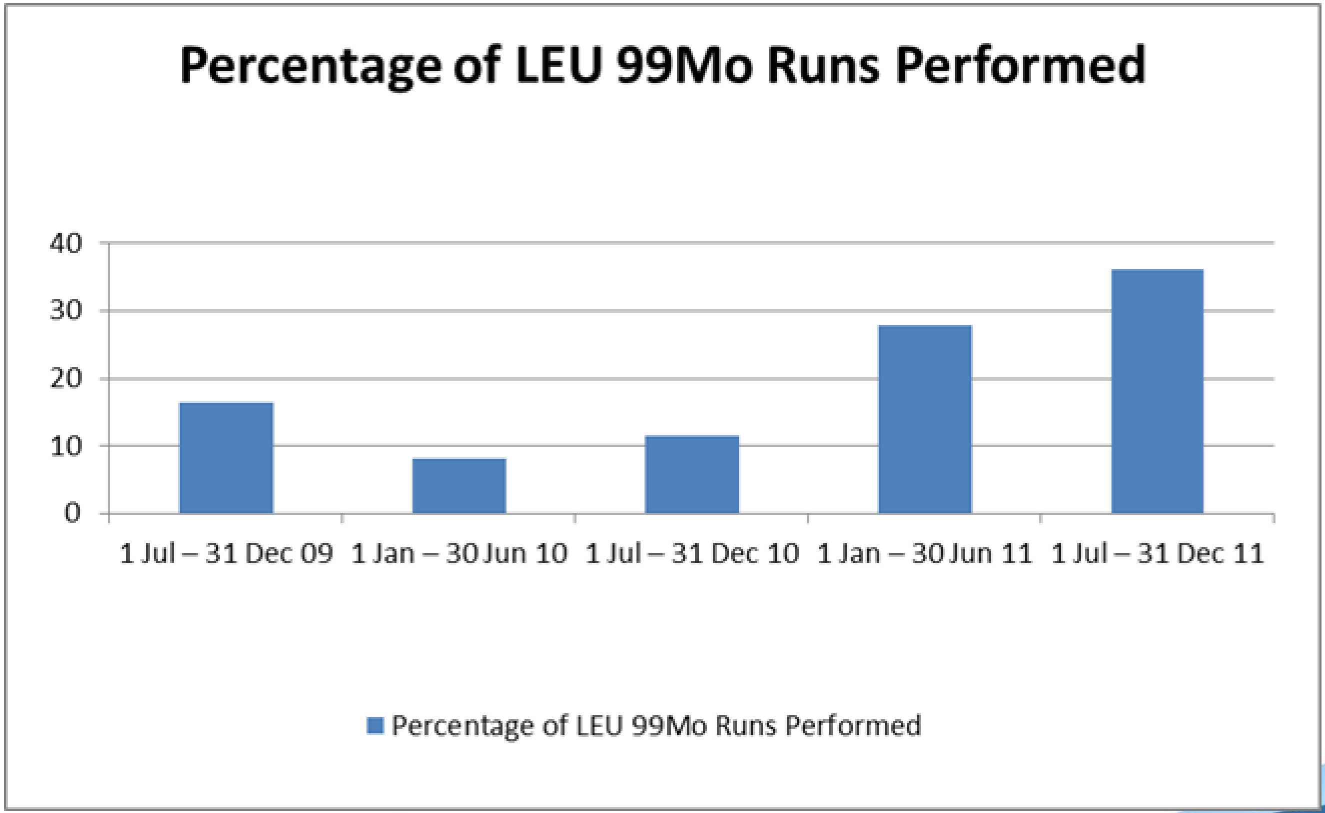
Current Status

New Dissolution Cell (currently under construction)

(Designed specifically for LEU ^{99}Mo production)

Current Status



Data for 1 Jul – 31 Dec 11 estimated

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Impact of Conversion

- Loss of in-house ability to manufacture fuel assemblies and target plates
- Decrease in ^{99}Mo Production capacity due to less U235 loaded into the targets
- New uranium residue storage facility and additional dissolver line required

True impact →

- **Increased costs**
- **Decreased production capacity**

BUT it is feasible

Challenges

Customer appetite

- **Qualification of ^{99m}Tc generator manufacturer is significant and costly**
- **Customers generally see no benefit to themselves in sourcing LEU ^{99}Mo**
- **Mixed response to conversion**

Political will

- **Lacking in some countries but strong in others**
- **Clear, unambiguous and well communicated political support yields results**

Challenges

Regulatory Complexities

- **The regulatory framework in some countries is complex and cumbersome**
- **Generator manufacturers have to qualify their products with the individual regulators of each country in which they operate**

Challenges

Logistics

- **Production with both HEU and LEU targets while minimising disruption to supply is a challenge**
- **^{131}I production using LEU targets and the validation and individual medical regulator approval thereof is a major challenge**

Challenges

Economically sustainable ^{99}Mo production

- **NTP is a full-cost recovery company with no state subsidization**
- **The sustainability of the ^{99}Mo market depends on full cost recovery – irradiation, processing and waste**

Concluding Remarks

- Wonderful technological success achieved at large scale production volumes
- Great team effort with support from NNSA and AREVA/CERCA
- Solving the technical challenges of large scale ^{99}Mo production with LEU is but the beginning of conversion

Concluding Remarks

- Market will only be sustainable if the playing fields are level:
  - True full-cost recovery (including cost due to conversion) must be implemented
  - Irresponsible behavior of some producers and governments must cease
  - Generator producers must be prepared to pay the increased prices (and thereby ensure a long-term sustainable supply)

Thank you for your attention

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