NTP Radioisotopes SOC Ltd

Status Update on the $^{99}$Mo HEU/LEU Conversion Project in South Africa

G Ball

Mo-99 2013 Topical Meeting on Molybdenum-99 Technological Development
1-4 April 2013, Chicago
Outline

- Background
- Conversion Project
- Current Status
- The Way Forward
- Concerns
Background * NTP in Context

Minister of Energy

Necsa Board

Chief Executive Officer

Necsa Division

Necsa Division

Necsa Division

Necsa Division

Necsa Division

Necsa Division

NTP Radioisotopes (SOC) Ltd

AEC Amersham (SOC) Ltd

NTP Logistics (SOC) Ltd

Gammatec NDT Supplies (SOC) Ltd

Gamwave Gauteng (Pty) Ltd

NTP Radioisotopes – Europe S.A.

Other subsidiaries
Background * Product Portfolio

**Radiochemicals**

Mo-99, I-131, Lu-177

**Radioactive Sources**

Ir-192, Cs-137, Co-60

**Irradiation Services**

Neutron Transmutation doping of Silicon, Neutron Irradiation Services

**Radiopharmaceuticals**

NovaTec-P Tc-99 Generator, FDG, MIBG, Cold kits, I-131 Capsules and Solution

**Radiation Technology Products**

Transport containers
Background * Markets Served
Background * Mo-99 History

– Development work on HEU process commenced in late 1980’s
– First export Mo99 sales in Q4 1994
– 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 constructed and being commissioned (Required due to conversion)
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.

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

U-Al Dispersion target

Probably higher density target;
retrievable from clad
### Conversion Project

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LEU</th>
<th>HEU</th>
</tr>
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<tbody>
<tr>
<td>Meat</td>
<td>Dispersion</td>
<td>Alloy</td>
</tr>
<tr>
<td>Enrichment</td>
<td>19.75%</td>
<td>45.0%</td>
</tr>
<tr>
<td>Uranium density (g.cm(^{-3}))</td>
<td>2.75</td>
<td>1.42</td>
</tr>
<tr>
<td>Dimensions (mm)</td>
<td>200/50/1.66</td>
<td>200/50/1.66</td>
</tr>
<tr>
<td>Cladding</td>
<td>Alloy</td>
<td>Pure aluminium</td>
</tr>
<tr>
<td>U-235 Loading</td>
<td>Maintain (or minimise decrease)</td>
<td></td>
</tr>
</tbody>
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## Conversion Project

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>2007</td>
<td>Theoretical feasibility studies</td>
</tr>
<tr>
<td>2008</td>
<td>Cold and depleted uranium experiments</td>
</tr>
<tr>
<td>Oct 2009</td>
<td>NNR approval received for test stage and first hot runs commence</td>
</tr>
<tr>
<td>Mar/Apr 2010</td>
<td>Process validation runs performed</td>
</tr>
<tr>
<td>Jun 2010</td>
<td>Submission to NNR for routine LEU $^{99}$Mo production</td>
</tr>
<tr>
<td></td>
<td>Submission of DMF to Medical Regulators commenced</td>
</tr>
<tr>
<td>Jul 2010</td>
<td>Customer tests and validation runs commenced</td>
</tr>
<tr>
<td>Sep 2010</td>
<td>NNR approval received for routine operation with LEU</td>
</tr>
<tr>
<td>Sep 2010</td>
<td>US FDA approves LEU $^{99}$Mo for a customer in the US</td>
</tr>
<tr>
<td>Dec 2010</td>
<td>First large scale commercial FDA approved batch of LEU $^{99}$Mo produced and shipped to US for patient use</td>
</tr>
<tr>
<td>Jun 2011</td>
<td>Commercial supply of LEU $^{99}$Mo commenced</td>
</tr>
<tr>
<td>Mar 2012</td>
<td>Commenced with project to regain lost production capacity</td>
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Conversion Project

Technical issues:

– Target Specifications

– Changes to process due to change in target

– Simultaneously performing development work and routine production

– Routine HEU & LEU production

– Increased waste volumes
Conversion Project

Non-Technical issues:

– Customer appetite

– Regulatory complexities

– Inconsistency regarding ‘full cost recovery’
Current Status

– Increasing commercial supply to customers authorized to use LEU $^{99}$Mo

– Supply of LEU $^{99}$Mo to customers for testing & validation

– Significant investment in infrastructure
Current Status

% LEU Distribution relative to all LEU runs

2009 2010 2011 2012

% LEU Distribution
The Way Forward

**Target & Process Optimisation**

- Investigate feasibility of regaining lost production capacity (with existing target)
  - Increasing uranium density (target manufacturer)
  - Changing target geometry
  - Changes to reactor irradiation positions
- Status: Commenced in 2012
The Way Forward

**New High Density Target & Process Development**

- Work with existing international initiatives
  - Manufacturing qualification
  - Irradiation qualification
  - Waste handling
- Status: Ongoing
The Way Forward

Finalise Construction and Commissioning of Infrastructure

(Required due to Conversion)

– 3rd Dissolution line

– Uranium residue storage facilities

– Status: Commenced and to be completed progressively by June 2014
Concerns - $^{99}$Mo Value Chain

Sustainability?
Thank you for your attention