Trevor Blench and Prof Johan Slabber
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• Steenkampskraal Thorium Ltd. (STL) is a South African registered company, supported by private share holders and is based in Centurion
• STL is developing thorium containing fuel as an environmentally cleaner, safe and efficient energy source from the point at which the thorium is mined to the acquisition of fuel
• STL is designing a small modular High Temperature Reactor and a strategy for Fuel Production
Some Facts about Thorium

- Thorium is a naturally occurring radioactive element found in the earths crust
- Thorium is often produced as part of the tailings in Rare Earth Element separation processes
- It is approximately 4-5 times more abundant than uranium
- Thorium is not fissile but fertile; this means that thorium can capture a neutron to produce fissile $^{233}$U
- The fission of Thorium does not generate minor actinides
- Thorium containing fuel can facilitate the reduction of world-wide plutonium stockpiles
STL’s Initiative in RSA

- STL has built up a technical team of specialists to design and build High Temperature Reactors (HTR) and a fuel plant.
- Five years of engineering is completed on a $30\text{MW}_{th}$ and a $100\text{MW}_{th}$ HTR.
- STL calls its HTR a High Temperature Modular Reactor (HTMR).
- Marketing has been initiated in various countries.
- The objective is cleaner, safer, sustainable and affordable nuclear power and process heat for desalination.
Steenkampskraal Monazite Mine
Steenkampskraal Monazite Mine is located approximately 330 Km due north of Cape Town.

It is 70 KM North-Northwest of Vanrhynsdorp, the nearest town centre.
This is an existing underground Mine with the following distinct features:

- A high grade monazite vein deposit with visibly clear distinction between the ore body and the waste rock so that blasting and hauling of waste rock will be very minimal.
- It has high Th content too as an added value for nuclear fuel application.
- Environmental and Radiation Regulatory Authorizations are in place.
- Significant amount of work to restart the mine has already been done.
- Has a jurisdictional mine site area of 474 hectares.
- Surrounding farm areas of 6 990 hectares have been purchased as buffer zones for the mine operations.
• Drilling has been extensive enough to delineate the ore body just around the Koppie.
• Potential exists to find the mineralization beyond the current drilled locations.
Rare Earth Production

- Ore will be crushed, milled and beneficiated to produce monazite concentrates.
- Monazite concentrate will chemically be treated to produce purified RE nitrate that will be shipped to a Toll separation Refinery.
- Cerium will be removed and stored on site.
- Thorium will be purified for nuclear fuel fabrication.
R&D on Thorium Fuel Compositions
Thor Energy Oslo, Norway

- STL is part of the International Thorium Consortium
- Aim is to commercialize thorium as a supplement fuel in conventional nuclear reactors
- Irradiation testing of thorium-oxide LWR pellets in the Halden Reactor (Norway) started on 25 April 2013
- Second round of test irradiation is underway.
- Two rigs in the reactor containing various Thorium fuel compositions

Thorium-oxide pellets
HTMR Nuclear Power Plant
• The HTMR100 and HTMR30 are Gen IV 100MW\textsubscript{t} and 30MW\textsubscript{t} helium cooled reactors that feature a uranium, uranium-thorium or plutonium-thorium fuel cycles

• Ceramic spherical fuel elements are used in an OTTO cycle and allows on-line fuelling. Used fuel only requires simple dry cooling

• This fuel technology has excellent demonstrated safety characteristics

• The HTMR can be utilised for power generation and process heat applications, specifically desalination

• Small size and modular construction result in shorter building times and lower costs and allows for future modular expansion. The Reactor Vessel is designed to be road transportable
# HTMR Main Parameters

## Overall Plant Data (PS)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor power rating</td>
<td>25 to 100 MW&lt;sub&gt;th Nominal&lt;/sub&gt;</td>
</tr>
<tr>
<td>Net electric power</td>
<td>&lt;35 MW&lt;sub&gt;e Nominal&lt;/sub&gt;</td>
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</table>

## Primary System Data (NSSS)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Helium inlet/outlet Temperature</td>
<td>250 / 750°C</td>
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<tr>
<td>Primary pressure</td>
<td>4 MPa (abs)</td>
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</table>

## Secondary System Data (PCS)

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Pressure</td>
<td>5.4 MPa (abs)</td>
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<tr>
<td>Inlet temperature</td>
<td>540°C</td>
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## Fuel

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Fuel sphere diameter</td>
<td>60 mm</td>
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<tr>
<td>Number of passes through the core (OTTO)</td>
<td>1</td>
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<tr>
<td>Heavy metal in fuel elements</td>
<td>To guarantee inherent safety</td>
</tr>
<tr>
<td>Enrichment</td>
<td>10-15%</td>
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<tr>
<td>Fuel Compositions</td>
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<tr>
<td>Uranium dioxide</td>
<td></td>
</tr>
<tr>
<td>Uranium/Thorium dioxide</td>
<td></td>
</tr>
<tr>
<td>Plutonium/Thorium dioxide</td>
<td></td>
</tr>
</tbody>
</table>
Core Ceramic Structures

Graphite core structures
Complete assembly

Bottom core structures

Upper core structures
Helium Flow Path
Steam Generator

- Main Helium circulators
- Return gas plenum
- Steam pipe connecting vessel
- Vessel Support
- Hot gas duct
- Steam Generator Tube bundle support
- Tube bundle
- Vessel restraints
- Feed water pipe connecting vessel
DLOFC Power Profile (Tinte)
DLOFC Temperature Profile (Tinte)
Thank-you