CLEAN POWER AFRICA
CONFERENCE & EXPO 2012

Presents:
HYDROPOWER AFRICA

4 - 5 September 2012
Cape Town, SOUTH AFRICA

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VOITH

New approaches to a smarter hydropower industry in Africa
INGULA Successful construction of a large scale pump storage plant

• Project background
• Scope of works
• Logistics
• 3D Modeling
• Erection sequence power unit
• Actual progress and project forecast
History

- Studies on appropriate sites for a large pump storage power plant initiated in the 1980’s
- Name change from Bramhoek to Ingula announced in 03/2007
- Contract award for the E&M equipment in 09/2008
- Excavation of the cavern started in 10/2008
- Successful Model Test performed in 08/2009
- Start of installation of the first draft tube in 03/2012
Location

to Johannesburg, ~270 km

to Durban, ~190 km
Scope of works

- HV sub-station
- Generator
- Turbine
- Hydraulic Steel Structure (Head water side)
- Hydraulic Steel Structure (Tail race side)
- HV Transformer
- HV transmission line
- Inlet valve

Control & Monitoring System:
- CCR equipment
- Data Bus
- Communication systems
- Component monitoring

M-BoP Systems:
- Fire Fighting (CO₂ + water)
- Cooling Water
- Dewatering + Drainage
- Cranes

E-BoP Systems:
- DC and Batteries
- LV / MV - AC supply
- Protection systems
- Power distributions

M-BoP Systems - Fire Fighting (Water) - Cooling Water - Dewatering/ Drainage - HVAC

Scope of works - other contractors

www.hydropowerafrica.com
# Technical Parameters

<table>
<thead>
<tr>
<th></th>
<th>Generation</th>
<th>Pump/ Motor</th>
</tr>
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<tbody>
<tr>
<td>Output Turbine</td>
<td>342 MW*</td>
<td>323 MW**</td>
</tr>
<tr>
<td>Out/Input Motor Generator</td>
<td>373,2 MVA</td>
<td>394,7 MVA</td>
</tr>
<tr>
<td>Power factor</td>
<td>0,90</td>
<td>0,95</td>
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* Net head  
** Max. static head
Technical Parameters

<p>| | | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Number of units:</strong></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Net Head</td>
<td>441 m</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>429 rpm</td>
<td></td>
</tr>
<tr>
<td>Runner diameter</td>
<td>4170 mm</td>
<td></td>
</tr>
<tr>
<td>Generator voltage</td>
<td>18 kV</td>
<td></td>
</tr>
<tr>
<td>Rotating mass</td>
<td>524 Tons</td>
<td></td>
</tr>
<tr>
<td>MIV weight</td>
<td>165 Tons</td>
<td></td>
</tr>
<tr>
<td>Runner weight</td>
<td>26 Tons</td>
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Technical Highlights
Individual Gate Control

• Individual control of stay vanes
• Easy access to head cover and guide bearing
• No shear pins or guide vane brake necessary
Technical Highlights
High speed self oil circulation system

- Self oil circulation system applicable up to 70m/s circumferential speed
- Verified technology background, experimental investigation on large scale model
- High maintainability due to omission of forced oil circulation pump
Technical Highlights
High speed self oil circulation system

Self Oil Circulation System
~ Oil Flow Volume / Construction of Oil Inlet Guide ~

- With Oil Inlet guide (both Rotational & Stationary)
- Without Oil Inlet Guide (Stationary)
- Without Oil Inlet Guide (Rotationary)
Logistic Overview

USA: MIV

Brazil: Turbine Parts

South Africa: Turbine Parts

Kenya: Turbine Parts

Europe: Miscellaneous

China: Turbine/Generator Parts

Japan: Generator Parts

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Main Components

- Spiral Case (14400x6130x3300 mm; 86 tons)
- MIV (4800x5420x3700 mm; 135 tons)
- Head Cover (6000x6000x1450 mm, 63,5 tons)
3D Modeling

- The integration of power unit and auxiliaries systems is engineered in 3D
- Allows various views from different directions
- Easy detection of Interferences between different systems
- 3D model is the single database for all arrangements and foundation plans
Main Area of Cavern

Bus Duct Tunnels

Transformer Hall

Machine Hall

Draft Tube

Access to cavern
Cavern Floors
Cross section Unit 4
Main Inlet Valve (MIV) Pit
Erection Sequence

Installation of Generator

4th STAGE CONCRETE: CONCRETING OF SPIRAL CASE UP TO EL 1190.750
2nd STAGE CONCRETE: CONCRETING OF DRAFT TUBE
3rd STAGE CONCRETE: CONCRETING OF SUPPORT RING
GRouting OF SUPPORT RING
GROUTING OF SPIRAL CASE
1st STAGE CONCRETE: BEFORE DRAFT TUBE INSTALLATION

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Actual situation - site

- DT U3 completed, concreting in progress
- DT U4 installation started
- DT U2 & U1 installation start in 09/11 - 2012
Forecast

- Main erection for Turbines and Generators to be started in 2013
- Commissioning first unit in early 2014
- Commissioning last unit in late 2014
- After Commissioning Ingula will be the largest pump storage power plant in Africa
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Any questions?