NUCLEOELECTRICA ARGENTINA S.A.
Life Extension Project Management
Embalse Nuclear Power Plant
CONFERENCIA LATINOAMERICANA DE LA ENERGIA NUCLEAR
October 25/26th, 2016.
BUENOS AIRES, ARGENTINA
R. O. Semmoloni, Eng.

Embalse Life Extension Project
Embalse NPP Life Extension Project

Contents

1. Introduction
   • Main characteristics of Embalse NPP

2. Overall Description of Embalse NPP Life Extension Project
   • Objective
   • Overall guidelines.
   • Legal frame.
   • Project Phases.

3. Project Scope
   • Reactor Retubing.
   • Replacement of 4 Steam Generators.
   • Facility Updating.
   • Power uprating.

4. Present Situation. Schedule

5. Cost and financing.

6. Concluding remarks
CNE Important Milestones

• CONTRACT SIGNATURE: DECEMBER 20th, 1973
• WORKS BEGAN: MAY 7th, 1974
• ERECTION ENDED: BY MID 1981
• FIRST CRITICALITY: MARCH 13th, 1983
• FIRST NET CONNECTION: APRIL 25th, 1983
• 100 PER CENT POWER: SEPTEMBER 15th, 1983
• COMMERCIAL OPERATION FIRST CYCLE: JANUARY 1st, 1984
• COMMERCIAL OPERATION FIRST CYCLE END: DECEMBER 31st, 2015
CNE Main Characteristics

- Pressure Tubes Reactor–CANDU type
- Coolant and Moderator: Heavy Water
- Fuel: Natural Uranium

- Gross electrical power: 648 MW
- Net electric power: 600 MW
- Turbogroup: 1 high pressure stage and 3-stage low pressure.
- Three phase generation 21 KV, 50 Hz
- Transformation to 500 KV 50 Hz.
1. Tapón de Cierre. Channel Closure
2. inserto de Sello de Cierre. Closure seal insert.
3. Acoplamiento del Alimentador. Feeder coupling.
17. Fuelle Anular del Canal. Channel annulus bellows.
Life Extension Project Embalse NPP.

Objectives

• Extend the life of the NPP for another 30 years.
• To adapt the system to the new regulatory requirements.
• Increasing the electrical power
General Guidelines Project

• Integrated Project Management under the responsibility of NASA.
• Participation of the designers of nuclear and conventional island.
• Development and qualification of domestic suppliers.
Project Phasis

Phase 1: Comprises all necessary to define the scope and estimate the overall cost of refurbishment activities.

Phase 2: Includes purchase management, execution of infrastructure, component manufacturing, training, planning and programming.

Phase 3:

Refurbishment

Enero 2016 - Marzo 2018

Project Scope

Fuel Channel and Feeders Replacement

Steam Generators Replacement

Power Up-rate

Update / improvements to the safety of the Nuclear Power Plant
Fuel Channel and feeders Replacement

Alimentadores (Feeders)

Canales Combustibles
fuel channel
Retubado. Fuel Channel and feeders Replacement

Tapón de Cierre (Channel Closure).

Tapón de blindaje (Shield Plug)

Tubo de Calandria. Calandria tube.

Extremo de cierre (End fitting)

Tubo de presión, Pressure tube.

Alimentadores. (Feeders)
Reactor Retubing

**Reactor Components**
- End-fittings, Calandria tubes, Shield Plugs, Pressure Tubes, Feeders, End fittings

**Special Tools and Equipment. Staff Training.**

**Auxiliary Installations**
- Construction and renovation of approx. 8000 m² of storage facilities for reactor components, tools, making feeders, staff training. Canisters and storage containers for radioactive waste discharged (pressure tube, calandria tube, End fittings).
- Facilities and containers for radioactive waste storage medium and low.
Steam Generators Replacement

312 new primary moisture separators manufacture

4 new replacement cartridges manufacture:

Storage facility used cartridges
Steam Generators Replacement

Cut steam drum and replacement of 312 primary moisture separators.

Cartridges Replacement through the airlock equipment.

Back-up Supports Replacement

Modifying lower side supports

Cut and Welding Primary lines
POWER UP-RATE

Up-rating assessment for the NSP:
- Thermal power up-rating from 2015 MWt up to 2064 MWt
- Safety Report review

Up-rating assessment for the BOP:
- Two additional High Pressure Pre-heater
- Two additional booster pumps in the circuit
- Steam Generators Feed-water temperature ingress increase from 158°C up to 188°C
- Rotor change with new forged discs
### POWER UPRATE

**Increased electric power 35MW**

<table>
<thead>
<tr>
<th></th>
<th>Present Configuration</th>
<th>2015</th>
<th>648</th>
<th>incr. Mwe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Efficiency Improvement of BOP and Turbin/Generator</td>
<td>2015</td>
<td>656</td>
<td>+ 8</td>
</tr>
<tr>
<td>2</td>
<td>NSP Power Increase</td>
<td>2064</td>
<td>670</td>
<td>+ 14</td>
</tr>
<tr>
<td>3</td>
<td>5th Pre-heater</td>
<td>2064</td>
<td>683</td>
<td>+ 13</td>
</tr>
<tr>
<td>4</td>
<td>Final Configuration</td>
<td>2064</td>
<td>683</td>
<td>35</td>
</tr>
</tbody>
</table>

**Total Increase:** from 648 to 683 MWe (+ 35)
Actualización de la Instalación.

Update / improvements to safety of the Nuclear Power Plant

• Improvements in safety systems
  • (Shutdown System No. 1 and No. 2,
  • EPS, (Emergency Power System)
  • ECC, (Emergency Core Cooling System)
  • EWS (Emergency Water Supply System)
• Installation of passive catalytic hydrogen recombiners (PAR) in the reactor building.
• Installation of a filtered venting system and controlled containment.
<table>
<thead>
<tr>
<th>ACTIVITIES</th>
<th>Progress</th>
<th>Planned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Activities CNE</td>
<td>1,90%</td>
<td>1,90%</td>
</tr>
<tr>
<td>1 - Fuel Channel And Feeders replacement</td>
<td>4,97%</td>
<td>5,84%</td>
</tr>
<tr>
<td>2 - Steam Generators</td>
<td>2,72%</td>
<td>5,18%</td>
</tr>
<tr>
<td>3- Installation Update.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IyC Systems Assembly</td>
<td>3.1 - Nueva Computadora de Control DCC</td>
<td>0,49%</td>
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<tr>
<td></td>
<td>3.2 - Programa de Calificación Ambiental (EQ)</td>
<td>0,13%</td>
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<tr>
<td>Electric Systems Assembly</td>
<td>3.3 - Nuevos Diesel Clase III -</td>
<td>0,97%</td>
</tr>
<tr>
<td></td>
<td>3.5/3.6/3.7/3.8 - Tareas de Montaje Eléctrico</td>
<td>1,07%</td>
</tr>
<tr>
<td>Engineering</td>
<td>3.9 - Modificaciones ECC</td>
<td>1,00%</td>
</tr>
<tr>
<td></td>
<td>3.10 - CV-RD</td>
<td>0,02%</td>
</tr>
<tr>
<td></td>
<td>3.11 - EWS</td>
<td>0,95%</td>
</tr>
<tr>
<td></td>
<td>3.12 - EPS</td>
<td>0,92%</td>
</tr>
<tr>
<td></td>
<td>3.13.1 - SDS1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.13.2 - SDS2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.13.3 - ROP 1</td>
<td>0,37%</td>
</tr>
<tr>
<td></td>
<td>3.13.4 - ROP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.13.5 - DISPARO DE BOMBA SPTC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.14 - PARs</td>
<td>0,00%</td>
</tr>
<tr>
<td></td>
<td>3.15 - Sistema de Venteo Filtrado de la contencion</td>
<td>0,09%</td>
</tr>
<tr>
<td>Mechanical Systems Assembly</td>
<td>3.16 - INSPECCION BOMBAS PRINCIPALES</td>
<td>0,00%</td>
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<tr>
<td></td>
<td>3.17 - INSPECCION BOMBAS REFRIGERACION DE PARADA</td>
<td>0,28%</td>
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<tr>
<td></td>
<td>3.18 - SISTEMA MODERADOR</td>
<td>0,68%</td>
</tr>
<tr>
<td></td>
<td>3.19 - INSPECCION BOMBA ECC</td>
<td>0,00%</td>
</tr>
<tr>
<td></td>
<td>3.20 - (Válvulas MSSV, ASDV, LCV y soportes MSL)</td>
<td>1,47%</td>
</tr>
<tr>
<td>4 – Power Uprate</td>
<td>4,96%</td>
<td>6,22%</td>
</tr>
<tr>
<td>Final Tasks CNE</td>
<td>0,00%</td>
<td>0,00%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>22,99%</td>
<td>36,37%</td>
</tr>
</tbody>
</table>
5. Cost and Financing

• Estimated total cost: USD 2.149 million

• Financing Sources:
  • Non-reimbursable contributions from the National Treasury
  • NASA Series II Financial Trust Fund
  • CAF Loan

• Funds Management:
  • «Embalse NPP Life Extension Project Trust Fund»
  • Trustee: Banco de Inversión y Comercio Exterior SA (BICE)
NASA Series II Financial Trust Fund

- Contract signed: May 2012: Issuance of Debt Securities (VRD A) for the amount of USD 189.4 million
- Main investor: Banco de la Nación Argentina.
- Interest rate: Libor (180 days) + 500 p.b.
- Amortization: 10 years (4/2014-4/2024)
- Trusted Assets: 80% future energy generated by the NPPS (CNA I, CNAII, CNE). (Purchase Agreement signed by NASA and CAMMESA).
CAF Loan
(Banco de Desarrollo de América Latina)

• On February 6th. 2013, a Loan Agreement was signed between CAF and the Argentine Republic amounting to USD 240 million for the partial financing of the Embalse NPP Life Extension Project.

• During 2013 disbursements (two) were made for a total amount of USD 96 million.

• In May 2014 a third disbursement amounting to USD 50 million was made.
CAF Loan

• Amount **240 million u$s**
• Interest rate: LIBOR for loans to 6 months+ 2.40%
• Grace period: 4 years

• Conditions during disbursement period: present quarterly reports with progress; cost; finance plan; Schedule of investments.

• **Loan Amortization**: 28 semiannual installments, consecutive capital and equal as possible, which will add accrued interest at maturity of each one. The first is paid at 54 months of signing the contract.

• Commitment Fee. 0.25% per year on undisbursed balances
• Financing Commission: 0.75%
• Evaluation costs: 100,000 U $ S
# Disbursements up to Sept. 30, 2016

(USD million)

<table>
<thead>
<tr>
<th></th>
<th>Up to 2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>by 09/30/16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Per YEAR</strong></td>
<td>196</td>
<td>362</td>
<td>336</td>
<td>245</td>
<td>249</td>
<td>139</td>
</tr>
<tr>
<td><strong>ACCUMULATED</strong></td>
<td>196</td>
<td>558</td>
<td>894</td>
<td>1.139</td>
<td>1.388</td>
<td>1.527</td>
</tr>
</tbody>
</table>
Concluding / Remarks:

- Recovery of domestic capacities
- Development of Suppliers

Development of the manufacturing of components

Development of Engineering and Erection Services

A bridge towards the new Nuclear Projects.
Muchas Gracias