The Enhanced CANDU 6™ Reactor

by

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The Enhanced CANDU 6 (EC6) is AECL’s 740 MWe class heavy water moderated pressure tube reactor designed to provide safe, reliable nuclear power.
Proven, Strong Foundation

• The EC6 design benefits from the proven principles and characteristics of the very successful CANDU 6 reactor. The EC6 offers reliability, flexibility in operation to load follow and the ability to be connected to most grids of most countries

• Proven CANDU reactor strengths include:
  ✓ Powered by natural Uranium
  ✓ Ease of installation with modular, horizontal fuel channel core
  ✓ Separate low temperature and pressure moderator
  ✓ Reactor vault filled with light water which surrounds the core
  ✓ On-power refuelling
  ✓ Two independent, passive, safety shutdown systems
  ✓ Reactor building access for on-power maintenance
CANDU 6 Plants Around the Globe

EC6 is based on AECL’s extremely successful CANDU 6 design

- **Canada**: 2 units
- **Argentina**: 1 unit
- **Romania**: 2 units
- **China**: 4 units
- **S. Korea**: 2 units
There are 11 CANDU 6 reactors operating worldwide with an average lifetime capacity factor of over 88% and with over 150 years of safe operation.
EC6 Highlights

- Major improvements incorporated in the EC6 design include:
  - Improved power plant output of up to 740 MWe gross
  - 60 year plant life with replacement of major components at around midlife
  - Natural uranium & flexible fuel capabilities
  - Target capacity factor of 90%
  - Reduced project schedule of 57 months from 1st concrete to in-service
  - More robust containment and increased passive safety features
  - Enhanced severe accident management with additional emergency heat removal systems
Fuel Cycle Flexibility

- The EC6 can accommodate a variety of fuel types and cycles
Design Enhancement Basis Principles

- New design enhancements based on direct feedback and interaction with operating CANDU utilities and current Safety/Licensing requirements:
  - Improved shutdown performance for improved Large LOCA margins
  - Improved fire protection systems (e.g. upgraded firewalls and penetrations, detectors, etc)
  - Additional reactor trip coverage
  - Automated and unitized back-up standby power and water systems
  - Additional design features to address severe accidents and aircraft crashes through provision of steel lined containment and ticker containment walls
- Simple Plant Operability and Maintainability
- Optimized Plant Maintenance Outages
- Modern Computers and Control/Display Systems
Gen III Criteria

The EC6 reactor has been studied against the following criteria

- Simplification
- Design Margin
- Human Factors
- Safety
- Design Basis vs. Safety Margin
- Regulatory Stabilization
- Standardization
- Proven Technology
- Maintainability

- Constructability
- Quality Assurance
- Economics
- Sabotage Protection
- Good Neighbour
Safety

- Passive Autocatalytic Recombiners (PARs) for long-term hydrogen control
- Calandria inlet nozzle/outlet port configuration reconfigured to improve flow distribution inside the Calandria to increase moderator subcooling
- Improved feeder material to increase operating life
- Emergency Heat Removal system for operation in case of severe accidents and provide additional heat sink capacity
- Structures designed to protect against external threats
- Automated Emergency Power Supply (EPS) Diesels
- Emergency Control Centre (EmCC) and expanded Safety Parameter Display System (SPDS)
Containment and Severe Accidents

Emergency Heat Removal System

COLLECTION OF WATER FROM RESERVE WATER TANK AND CALANDRIA AND CONDENSED MODERATOR/Calandria Vault Water During a Severe Accident

MODERATOR RECOVERY AND RECIRCULATION OF WATER TO THE RESERVE WATER TANK FOR CONTAINMENT COOLING
Operation & Maintenance

• 18 month maintenance outage frequency (target)
  – Electrical, water, & air supplies for on-power maintenance
  – Improved on-power testing
  – Reduced testing requirements by providing redundant equipment

• Enhanced shielding
  – <50 mSv/yr to any individual

• Equipment & systems design optimized to meet revised maintenance cycles
Constructability

- 57-month schedule from first concrete to in-service
- Second unit in-service 6 months later

- Advanced construction methods
  - Open-top using VHL crane
  - Modularization
  - Prefabrication
  - Concurrent / parallel work
  - Advanced work management tools
# Comparison of Key Enhancements

<table>
<thead>
<tr>
<th></th>
<th>CANDU 6*</th>
<th>EC6</th>
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<tbody>
<tr>
<td>Containment/Liner</td>
<td>1.07m epoxy-lined pre-stressed concrete</td>
<td>1.8m steel-lined with stronger concrete</td>
</tr>
<tr>
<td>Control Systems</td>
<td>DCC &amp; traditional control layout</td>
<td>DCS with human factors engineering</td>
</tr>
<tr>
<td>Computer Maintenance</td>
<td>Digital computer based</td>
<td>60% cost reduction</td>
</tr>
<tr>
<td>Pressure Tubes</td>
<td>4.2mm</td>
<td>~12.5% Thicker</td>
</tr>
<tr>
<td>Feeders</td>
<td>Carbon Steel</td>
<td>Improved corrosion resistance (&gt; Cr %)</td>
</tr>
<tr>
<td>Performance Factor</td>
<td>88.8% LCF fleet average</td>
<td>90% (target)</td>
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<tr>
<td>Power</td>
<td>680 MWe</td>
<td>Up to 740 MWe**</td>
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*Based on CANDU 6 at Point Lepreau  **Dependant on site conditions
Conclusions

• The Enhanced CANDU 6 (EC6) Reactor:
  ✓ Is based on proven CANDU 6 design & technology
  ✓ Incorporates extensive utility feedback
    • Improved maintenance & operability
  ✓ Delivers enhanced safety
  ✓ Uses natural uranium fuel & is flexible to alternatives
  ✓ Offers up to 90% capacity factor & 60 year design life
  ✓ Is economical and competitive
  ✓ Meets current International & Canadian standards
  ✓ Available for deployment readily