CAREM PROJECT STATUS

INPRO Dialogue Forum on Nuclear Energy Innovations
10-14 October 2011, Vienna, Austria
CAREM PROJECT STATUS

CAREM PROTOTYPE CONSTRUCTION AND LICENSING STATUS

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SUMMARY

- Introduction
- CAREM vs. CLASSICAL Design Comparison
- CAREM Main Characteristics
- CAREM Advantages
- Construction and Licensing Status
CAREM is a CNEA (Comisión Nacional de Energía Atómica) project.

This project consists in the development, design and construction of a small nuclear power plant.

A prototype of an electrical output of about 27 MW, CAREM 25, will be constructed in order to validate the innovation of CAREM concept. After that, a commercial version will be developed.
National Law N° 26566/2009: the law declares of national interest the design, construction and start up of CAREM prototype. CNEA was entrusted to complete these tasks.

The design basis is supported by the cumulative experience acquired in:

- Research Reactors design, construction and operation,
- Pressurized Heavy Water Reactors (PHWR) NPP operation, maintenance and improvement.
- The finalization of the CNA-II.
CAREM DESIGN vs. CLASSICAL DESIGN

CAREM: Integrated Reactor

Classical Design

Steam Generators

Pressurizer

Main Pumps

CRDM

RPV
CAREM DESIGN vs. CLASSICAL DESIGN

Classical PWR type

CRDM

Pressurizer

Steam – to Secondary

Condensate – from Secondary

Steam Generator (SG)

RPV

Core

Main Pump

Classical PWR type
CAREM DESIGN vs. CLASSICAL DESIGN

TRANSFORMATION: integration of the Steam Generators

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CAREM DESIGN vs. CLASSICAL DESIGN

CRDM

Self-pressurized

RPV

Condensate from Secondary
Steam to Secondary

Core

Steam Generator

Main Pump

TRANSFORMATION: Pressurizer elimination
CAREM DESIGN vs. CLASSICAL DESIGN

Integrated Hydraulic CRDM

Self-pressurized

Condensate from Secondary

Steam to Secondary

TRANSFORMATION:
Primary cooling System integration

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CAREM DESIGN vs. CLASSICAL DESIGN

Integrated Hydraulic CRDM

Self-pressurized

Condensate from Secondary

Steam to Secondary

TRANSFORMATION: CRDM integration

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MAIN CHARACTERISTICS

CORE AND FUEL ASSEMBLIES

- **61 FA (U235 enrichment: 3.1%)**
- **25 AE (Ag-In-Cd) • 16 AE for ACS • 9 AE for FSS**
- **Hexagonal FA with 127 positions**

“SPIDER”
18 Absorbing Rods
MAIN CHARACTERISTICS

STEAM GENERATION

- 12 identical “Mini-helical” vertical steam generators
- “Once-through” type
- Superheated steam
MAIN CHARACTERISTICS

HYDRAULIC CRDM
Adjust and Control System

✓ Belongs to the First Shutdown System.
✓ Movement by steps, controlled by pulses over a base flow.
✓ Shutdown by flow interruption.
✓ No strict requirement on total drop time.
MAIN CHARACTERISTICS

HYDRAULIC CRDM

Fast Shutdown System

- Belongs to the First Shutdown System
- Cylinder: inlet flow from the Down-comer
- Piston two positions: top and Bottom
- Shutdown by flow interruption
- Maximum total drop time: 2s
**Main Characteristics - Safety**

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<th>Function</th>
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<td>CONTROL RODS</td>
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**Main Characteristics - Redundancy**

- Redundancy: Physical Separation
- Passive
- Autonomy: 36 hs (Assuming 50% redundancy failure of each system)

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MAIN CHARACTERISTICS – SUM UP

- Integrated primary cooling system
- Integrated CRDM
- Integrated Steam Generation
- Self-pressurized
- Safety systems relying on passive features
- Autonomy: 36 hs
CAREM DESIGN ADVANTAGES

- No large LOCA.
- No LOFA.
- Rod ejection accident is eliminated.
- Large coolant inventory results in large thermal inertia and long response time.
- The use of less active components increases plant availability and load factor, reducing the frequency and kind of initiating events.
CAREM DESIGN ADVANTAGES

- Grace Period: 36 hs assuming 50 % redundancy failure.
- Grace Period Extension with Autonomous Systems (Residual Heat Removal System Pools cooling and water injection)
Construction and Licensing Status

- The construction of a high pressure and high temperature loop for testing the innovative Hydraulic Control Rod Drive Mechanism (CAPEM) was finished last year (Start-up is ongoing).

- This loop can also be adapted for testing Structural behavior of Fuels.
CONSTRUCTION AND LICENSING STATUS

High pressure and high temperature loop for testing the Hydraulic Control Rod Drive Mechanism

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Basic and detail engineering is being performed in different Technical areas.

The site facilities are being prepared to start the construction during the first half of 2012 (subjected to a permit by the Argentinean Regulatory Body).

Both the fuel pellets and the fuel itself are under development.

- Fuel pressure drop tests are being performed.
- Fuel rod irradiation tests are under preparation.
Several activities have been ongoing with the purpose of obtaining the Construction Permit for CAREM prototype:

- Information is being provided to and analyzed by the Regulatory Body according to the Licensing procedure.

- Site activities such as soil studies and environmental analysis have been performed.

- The Universidad Tecnológica Nacional - Facultad Regional Avellaneda (UTN-FRA) is performing the Environmental Impact Study of CAREM reactor prototype.
Contracts and agreements are being taken with different Argentinean stakeholders to perform detail engineering for buildings and process systems.

Balance of Plant Engineering has started this year.

Activities have been ongoing in order to purchase the Reactor Pressure Vessel to local suppliers.
International agreements have been made (Halden for fuel elements irradiation and TÜV Delft for Primary System Stability).

Product Lifecycle Management software (PLM) is being implemented to manage engineering information.
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THANK YOU!

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