

Proven Technology: CAREM approach

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CAREM



**INPRO Dialogue Forum on Nuclear Energy Innovations,
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CAREM

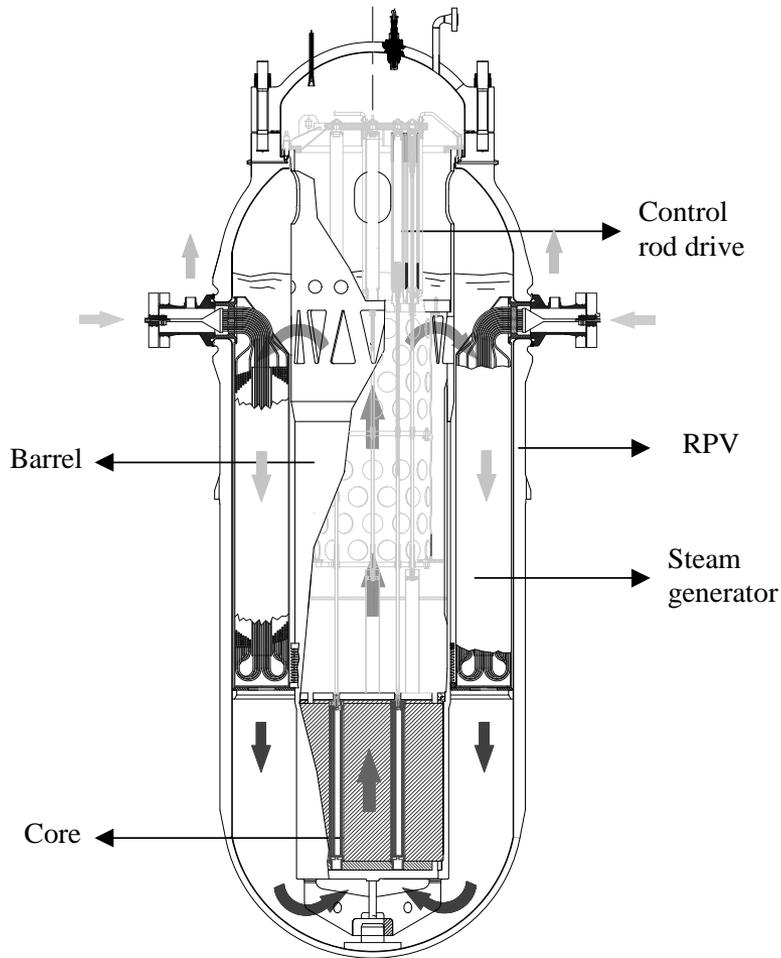
CAREM is a CNEA (Comisión Nacional de Energía Atómica) project.

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

First, a prototype of an electrical output of about 27 MW, CAREM 25, will be constructed in order to validate the innovation of CAREM concept and then developed to commercial version.

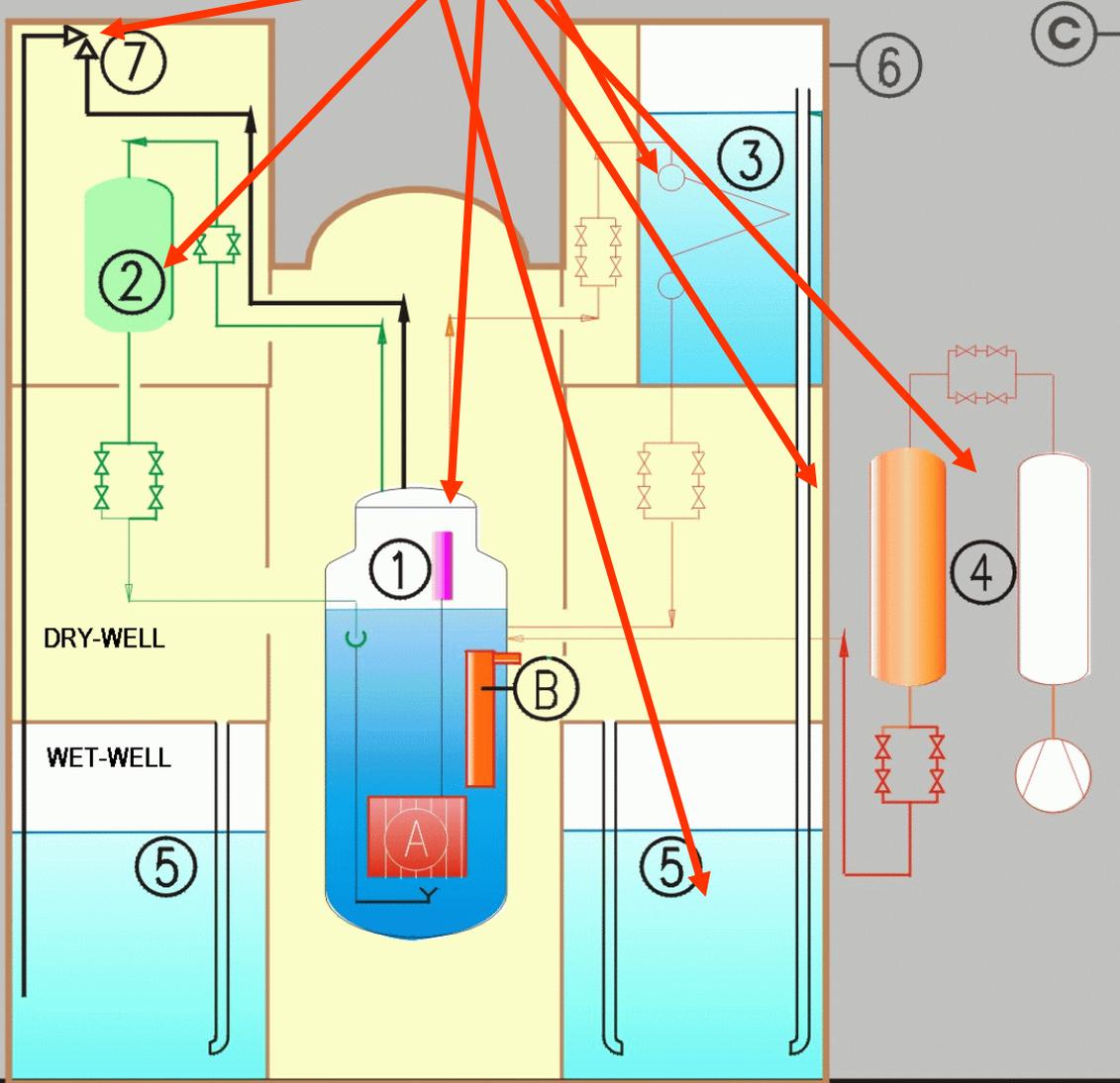


CAREM -25 Distinctive Features



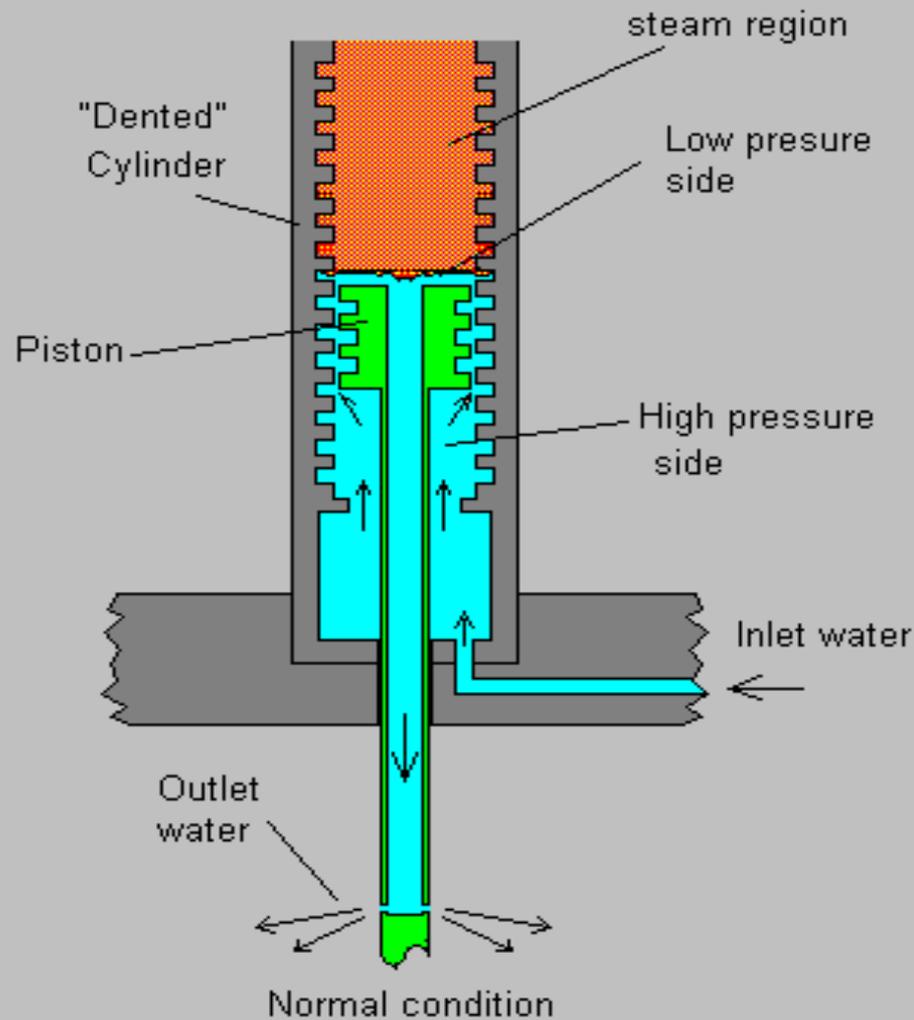
- **Integrated primary cooling system**
- **Primary cooling by natural circulation**
- **Self-pressurized**
- **Safety systems relying on passive features**

Safety Injection System Pressure Relief System Residual Heat Removal System



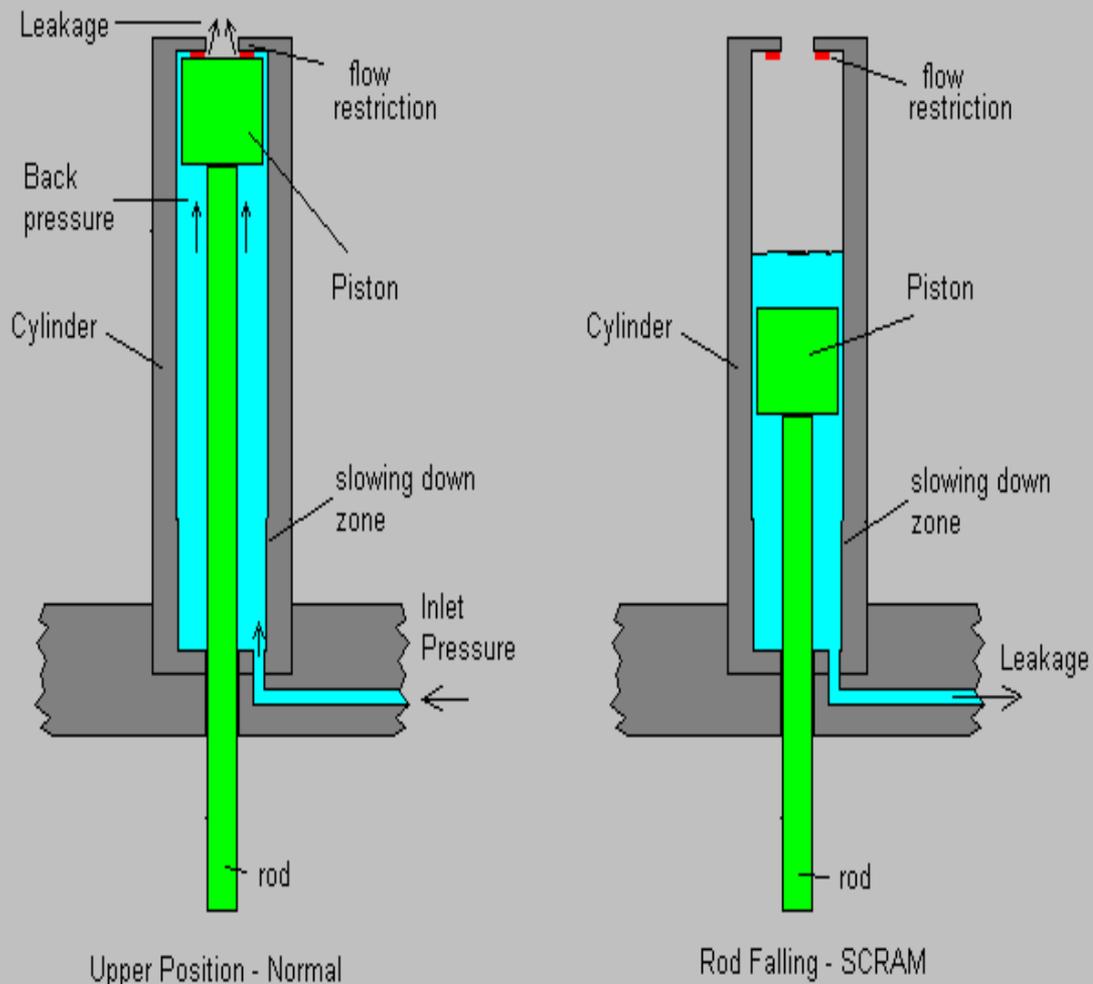
- Redundancy
- Independence
- Physical separation
- Diversification
- Fail safe

Containment and safety systems



Normal condition
**Hydraulic Control Rod Drive
 Adjust and Control System**
 (Simplified Operating Diagram)

Hydraulic Control Rods Drives



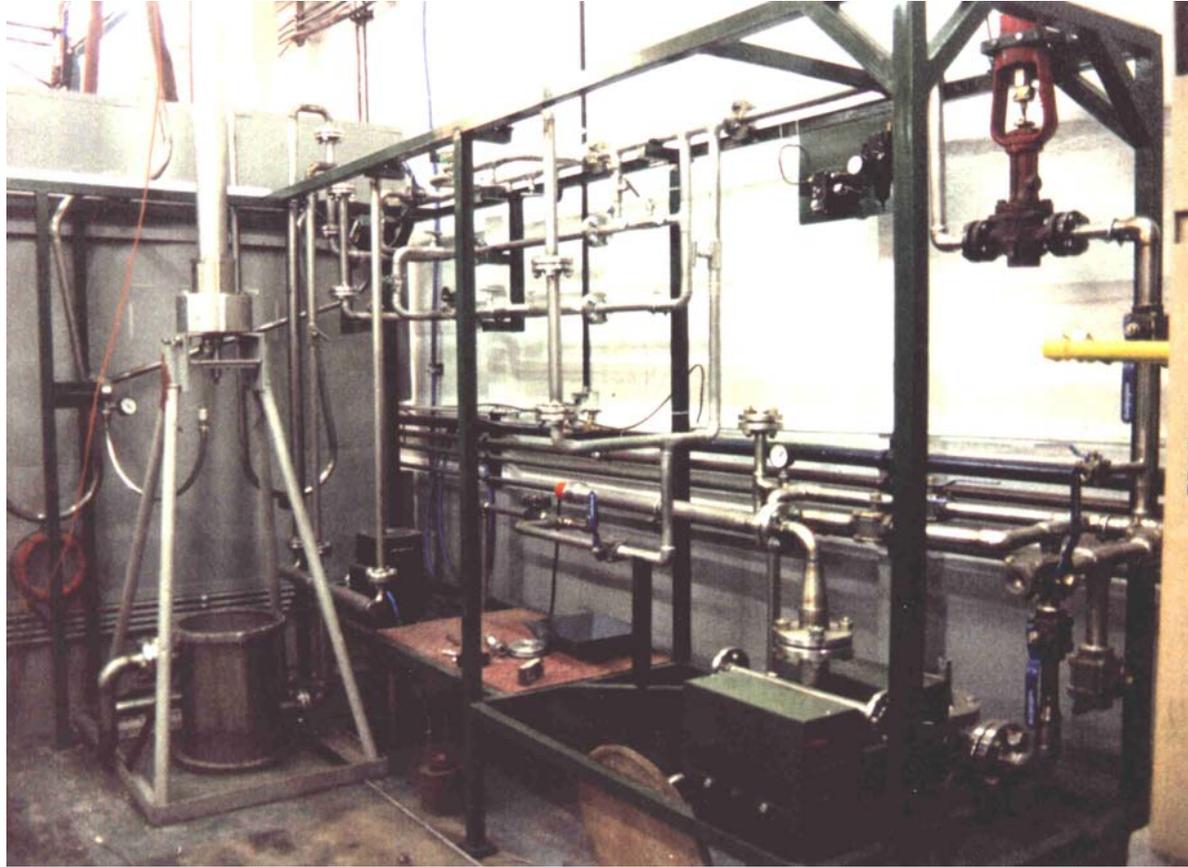
Hydraulic Control Rod Drive - Fast Extinction System

(Simplified Operating Diagram)

Hydraulic Control Rods Drives

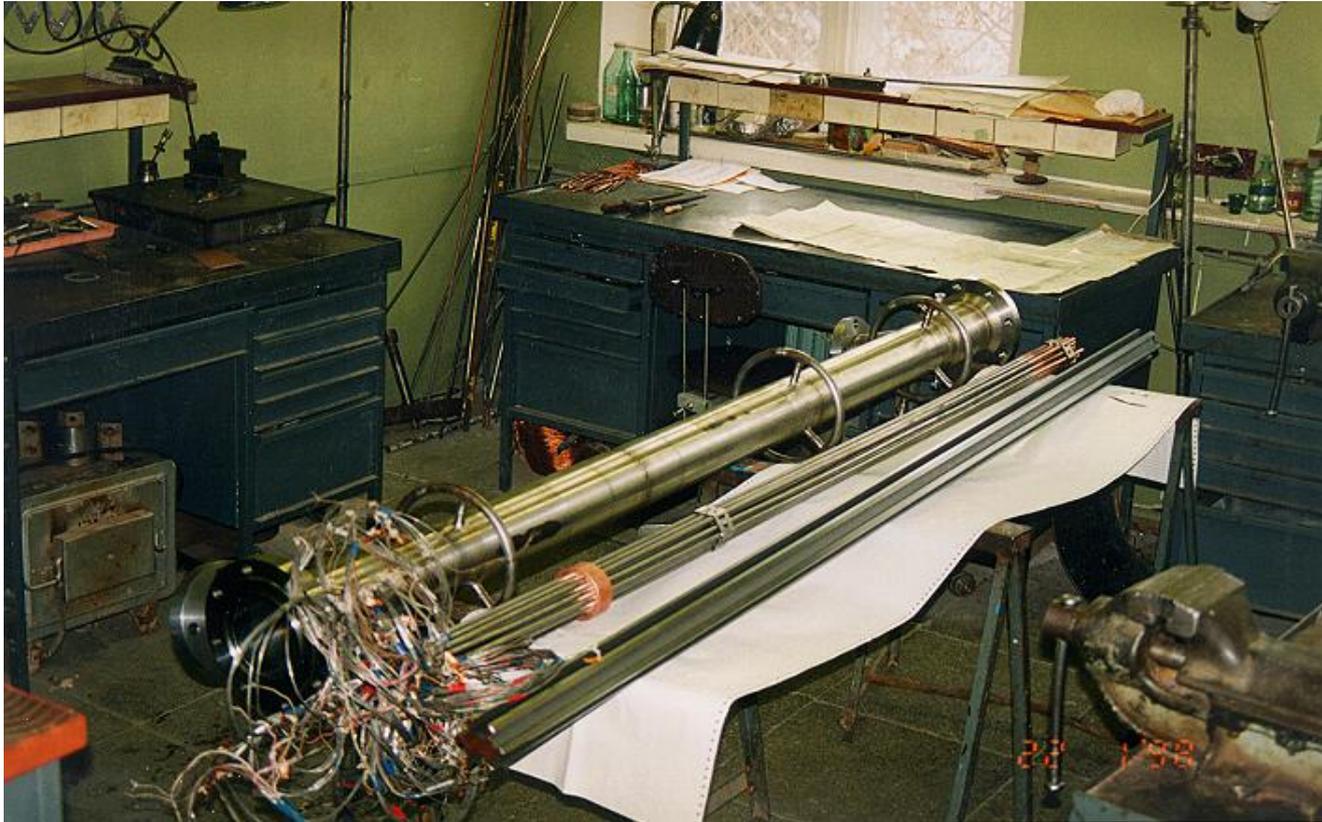


Hydraulic CRD Tests



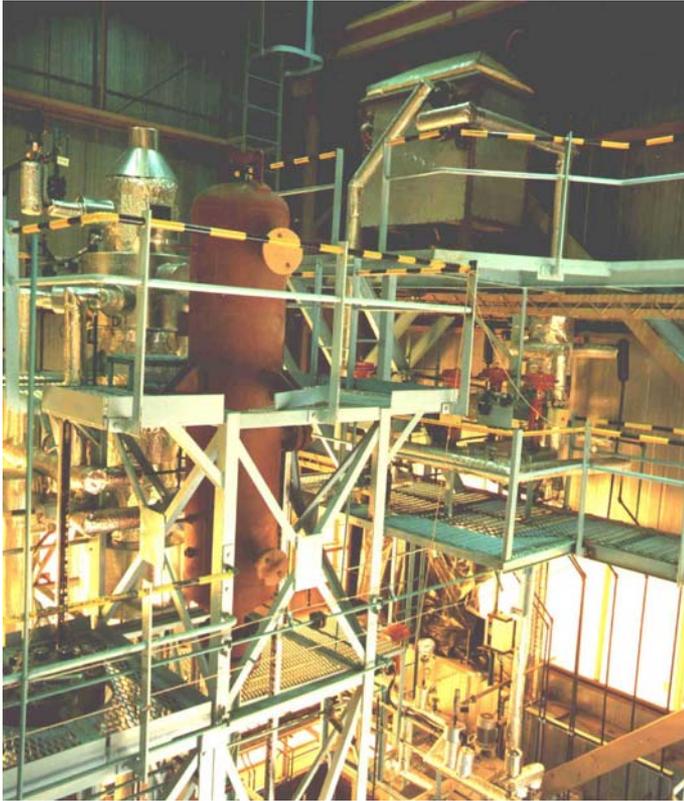
LOW Pressure Mechanism Test Rig

Thermal Limits and CHF Tests



LP Freon Loop Test (+250)
HP Water Loop Test (25)
TH LAB IPPE (Obninsk-Russia)

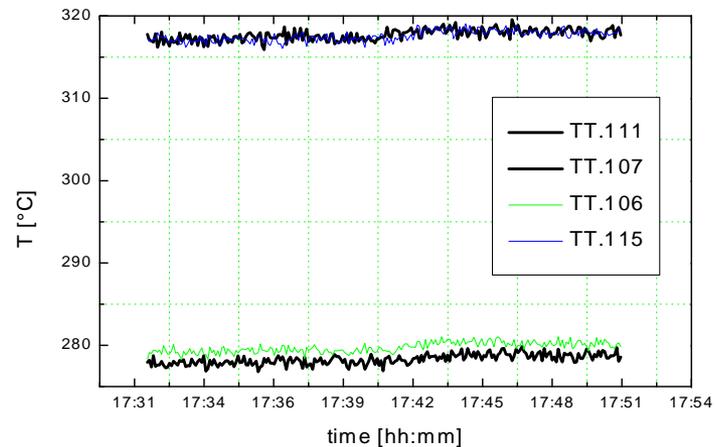
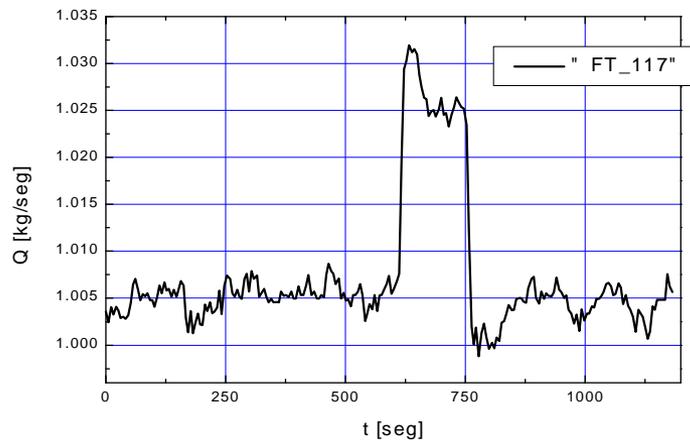
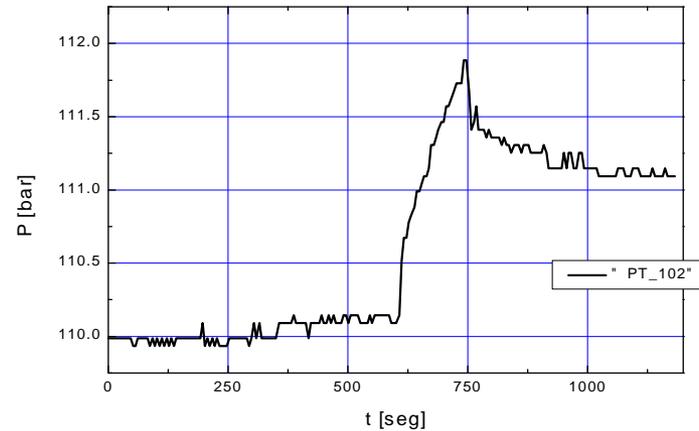
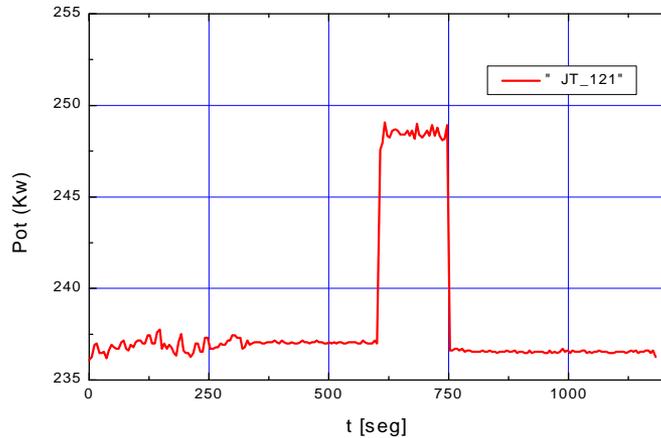
Natural Circulation and Self-pressurization Assessment



A High Pressure Natural Convection Loop (CAPCN) was constructed and operated to produce data in order to verify the thermal hydraulic tools used to design CAREM reactor, mainly its dynamical response.

This is accomplished by the validation of the calculation procedures and codes for the rig working in states that are very close to the operating states of CAREM reactor.

Natural Circulation and Self-pressurization Assessment



Natural Circulation and Self-pressurization Assessment

Many experiments were performed in order to investigate the thermal-hydraulic response of the system in conditions similar to CAREM operational states.

The influence of different parameters like vapor dome volume, hydraulic resistance and dome nitrogen pressure was studied.

Perturbations in the thermal power, heat removal and pressure relief were applied .

The dynamic responses at low pressure and temperatures, and with control feedback loops were also studied.

It was observed that around the operating point self-pressurized natural circulation was very stable, even with important deviation on the relevant parameters.

A representative group of transients were selected, in order to check computer models.

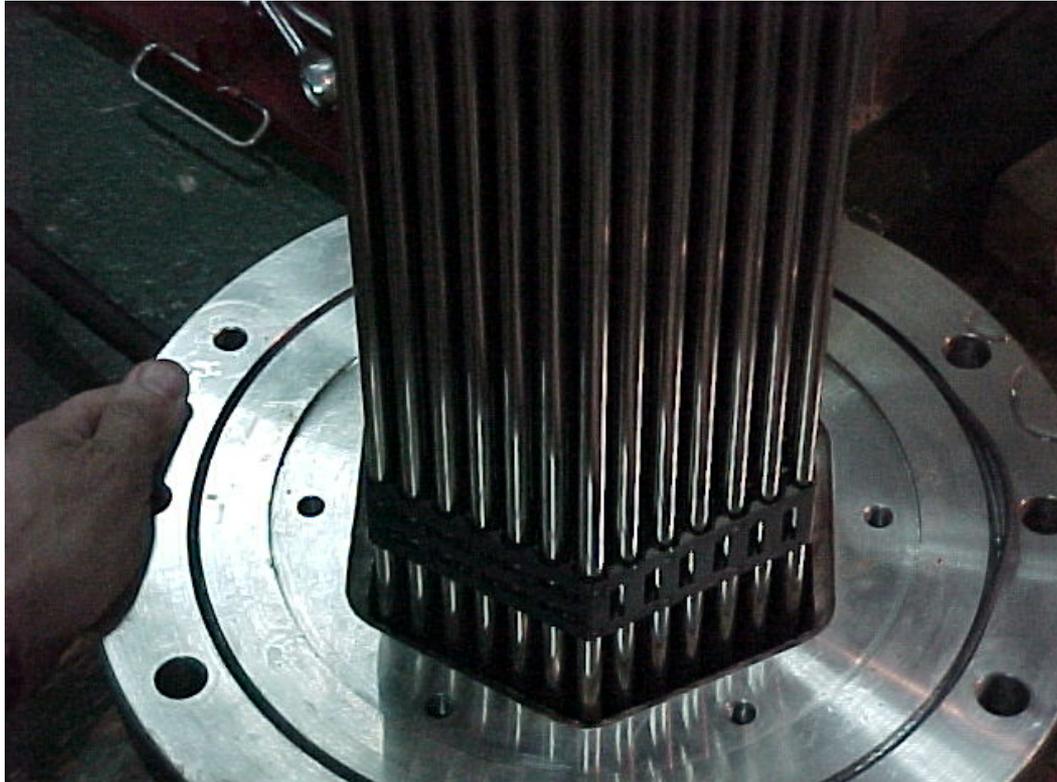


Neutronic Design and Critical Facility



Developments

Fuel Element



LOW Pressure Test Rig

Mock ups

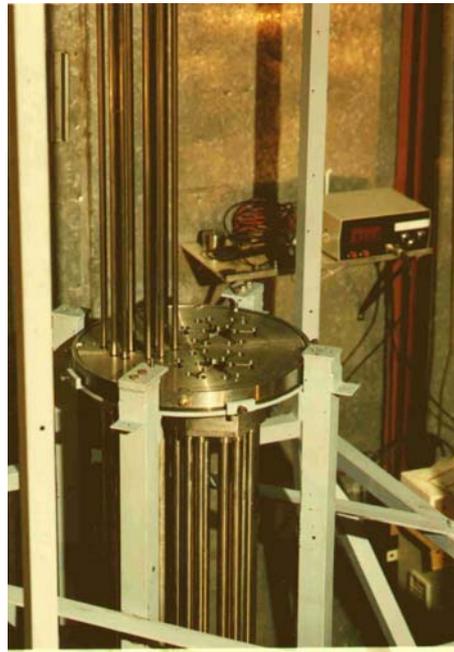
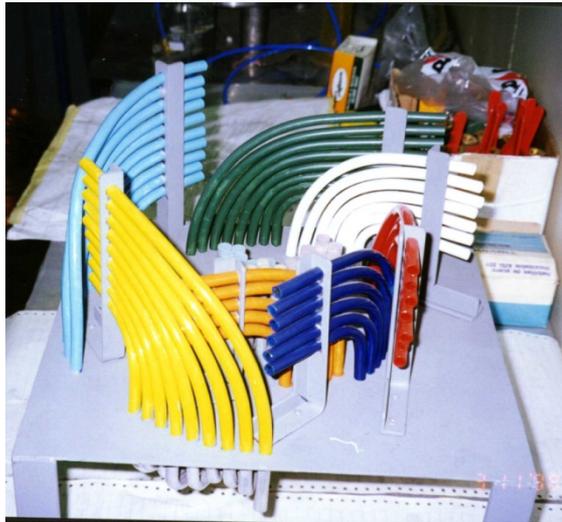
Mechanical design parameters and evaluation of manufacturing process

SG Lay Out

Fuel Manoeuvring Device (Refuelling)

I&C Feedthrough manufacturing

Special Welding



CAREM Prototype Construction and Licensing Status

National Law 26566/2009

On the 17th December 2009, the law declares of national interest the design, construction and start up of CAREM prototype, establishing a special regime. CNEA is entrusted to complete the task.

After several years of development the CAREM Project reached such a maturity level that the Argentine government decided the construction of CAREM prototype.

Several activities are ongoing with the purpose of obtaining the Construction License for CAREM Prototype.



CAREM Prototype Construction and Licensing Status



The construction of a high pressure and high temperature rig for testing the innovative Hydraulic Control Rod Drive Mechanism will be finished this year.

This rig can also be adapted for testing the structural behaviour of the FA.

CAREM Prototype Construction and Licensing Status

In the fuel area, both the fuel pellets and the FA itself are under development. Uranium dioxide, burnable poison oxide and the appropriate equipment for pellet manufacturing will soon be available. FA dummies that will be used to analyze mechanical integrity and test the behaviour under different flow conditions are under construction. Fuel rod irradiation tests are under preparation.

The use of robotics and the development of a plant simulator are included in the developments.



CAREM Prototype Construction and Licensing Status

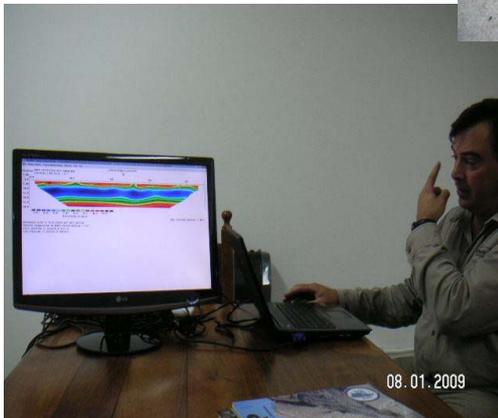
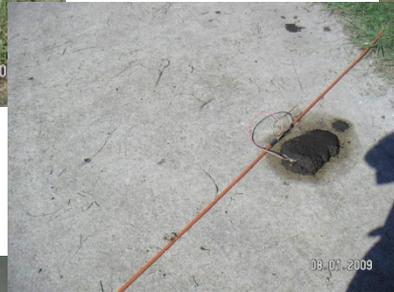
Several activities are ongoing with the purpose of obtaining the Construction License for CAREM Prototype.

The Quality System Manual and the Preliminary Safety Analysis Report were presented to the ARN in 2009.

Site activities such as soil studies and environmental analysis are being performed.



CAREM Prototype Construction and Licensing Status



Geotechnical Studies



CAREM Prototype Construction and Licensing Status

The Universidad Tecnológica Nacional - Facultad Regional Avellaneda (UTN-FRA) is performing the Environmental Impact Study of CAREM reactor prototype.

The Agreement between CNEA and UTN-FRA was signed the 26 of february 2009.

Environmental Impact Study



Conclusions

- **After several years of development the CAREM Project reached such a maturity level that the Argentine government decided the construction of CAREM prototype.**
- **Several activities are ongoing with the purpose of obtaining the Construction License for CAREM Prototype. The construction of the CAREM 25 is expected to be finished by the end of 2014.**

Conclusions

- **A specific experimental plan will be performed during CAREM prototype preliminary tests and commissioning.**
- **A by-product of CNEA activities to construct the CAREM 25 is the decision to create a division to provide services to NPP(s).**