

Adopted licensing scheme for an Argentinean modular reactor

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Outline

- CAREM25 prototype description
- CAREM25 licensing process
- Licensing current status
- Regulatory activities
- Final remarks

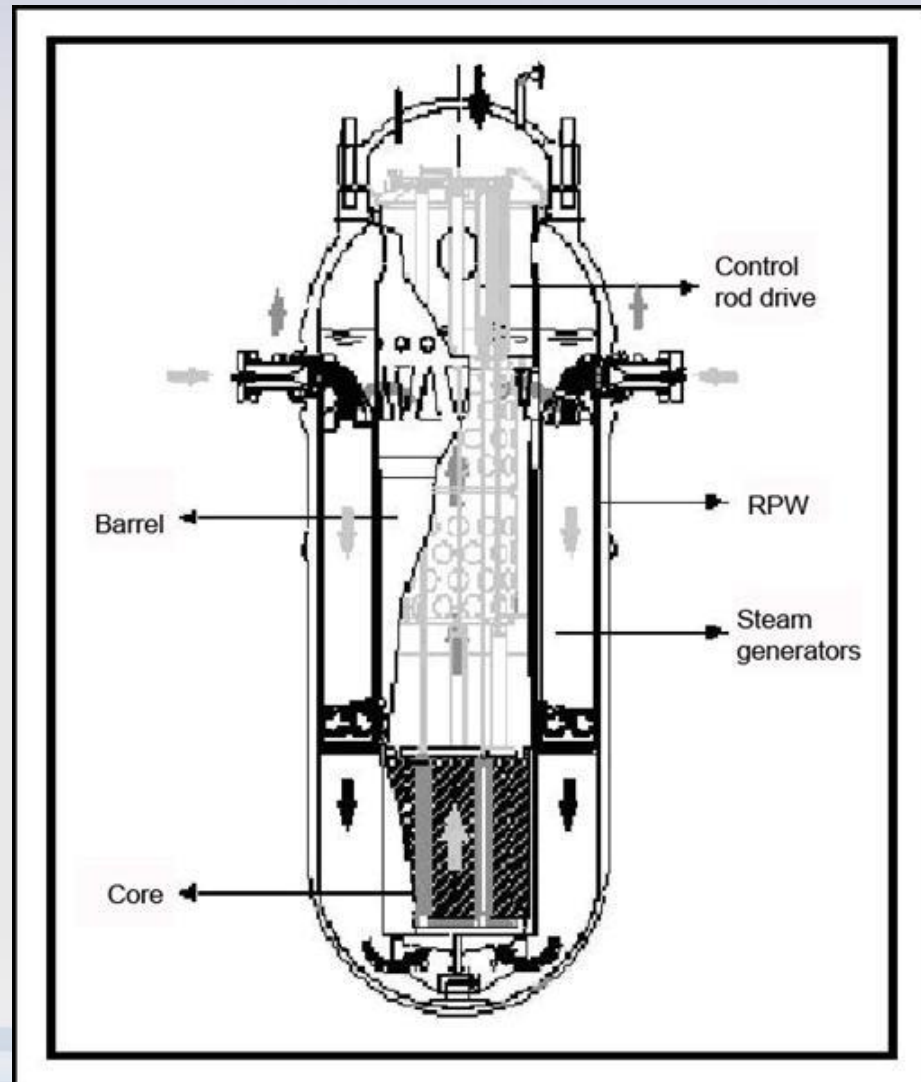
CAREM25 PROTOTYPE DESCRIPTION

CAREM-25 (100 MWth) is a light water low power reactor that has an indirect cycle reactor with some features that simplify its design and contributes to a higher safety level:

- Integrated primary cooling system
- Flow driven by natural circulation
- Self-pressurized primary system, and
- Safety systems relying on passive features

CAREM25 PROTOTYPE DESCRIPTION

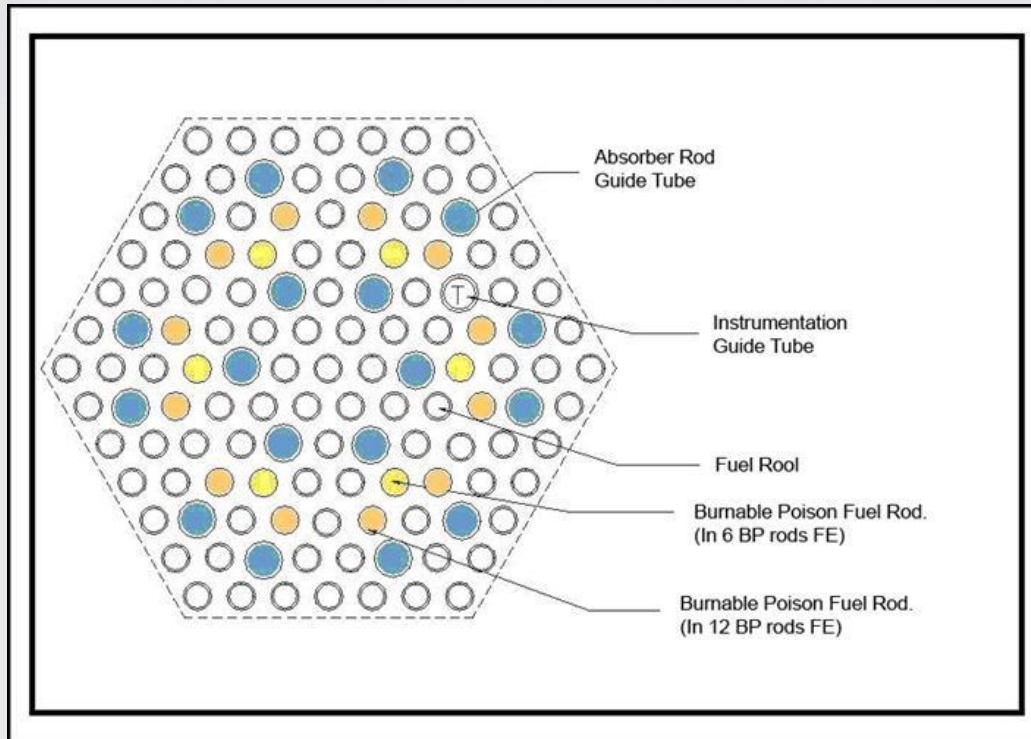
High-energy primary system, core, steam generators, primary coolant and steam dome are contained inside a single pressure vessel



Reactor Pressure Vessel

REACTOR CORE AND FUEL DESIGN

- The core has fuel assemblies of hexagonal cross section.
- Each fuel assembly contains:



- 108 fuel rods of 9 mm outer diameter, some with Gd_2O_3 as burnable poison
- 18 guide thimbles
- 1 instrumentation thimble
- Chemical poisons are not used for reactivity control during normal operation

Fuel Assembly Diagram. Fuel rods, guide thimbles and instrumentation thimble distribution

STEAM GENERATORS

- Twelve identical ‘Mini-helical’ vertical steam generators, of the “once-through” type equally distant from each other along the inner surface of the RPV.
- They produce superheated dry steam (30 K) @ 47 bar.

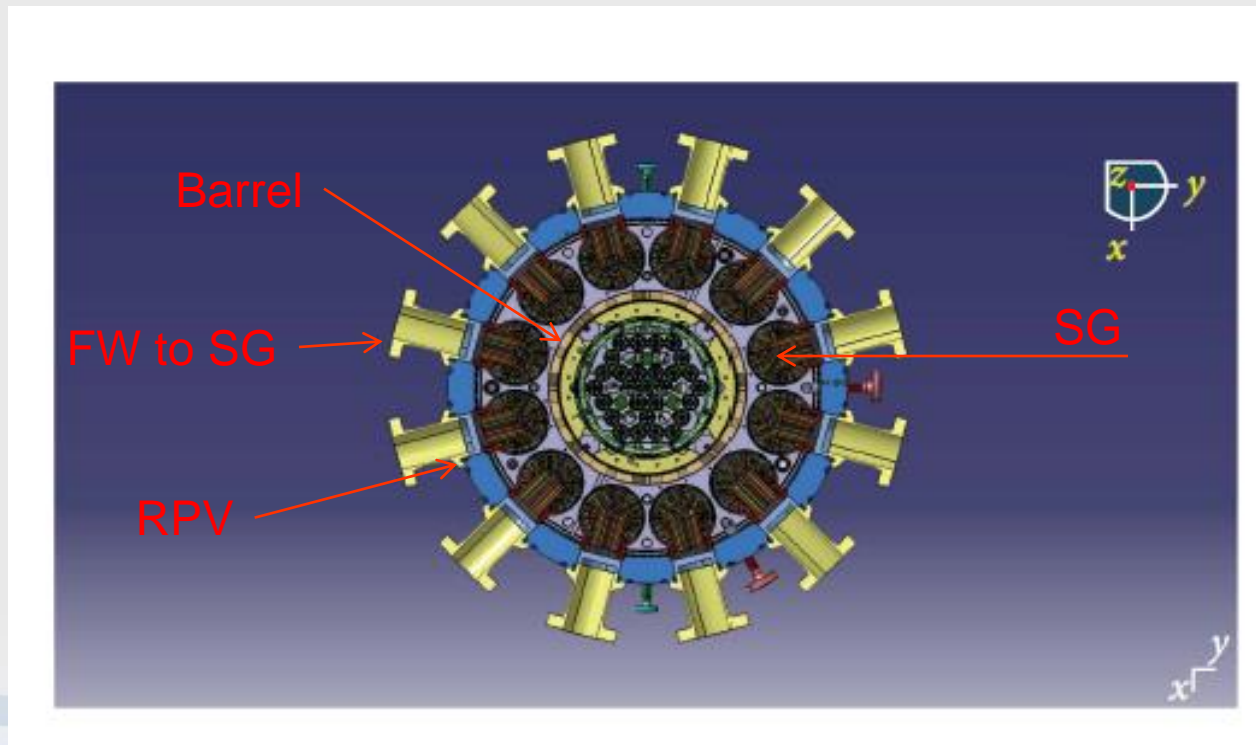


Figure from Science and Technology of Nuclear Installations
Volume 2011, Article ID 140373, Boado et. al.

CAREM25 LICENSING PROCESS

- The licensing process for a first kind prototype is different to the commonly used for NPP with proven engineering.
- ARN has developed CAREM25 licensing scheme in the frame of a '*non-routine practice*' as stated in ARN standard AR-10.1.1.
- By means of AR-10.1.1, CAREM25 might be considered as a «practice» to be conducted once or as a non-common practice carried out in nuclear installations.

CAREM25 LICENSING PROCESS

For the 'non-routine practice', the licensee (CNEA):

- has to meet AR safety standards (among other),
- is the only responsible for practice,
- has to ensure a high qualification level of the involved staff,
- has to ensure a high level of radiological safety,
- The installation/practice has to be designed for warranty on-service inspections,
- The authorization is just for construction and commissioning.

CAREM25 LICENSING PROCESS

To meet the above requirement, the licensing process for a prototype consists of a set of step-by-step “*Authorizations*” that has to be accomplished to proceed to the next step:

- Authorization for site use and construction (ongoing!)
- Authorization for fuel load
- Authorization to perform subcritical core tests
- Authorization for first criticality
- Authorization for zero power tests
- Authorization for increasing power
- Authorization for full power tests

To move from one stage to another and the approval of the Regulatory Authority is required.



AUTHORIZATION FOR SITE USE AND CONSTRUCTION

In order to get the *Authorization for Site Use and Construction*, the licensee submitted to ARN the following mandatory documentation:

- Radiological impact to the environment
- Design report (site, impact on adjacent facilities)
- Feasibility of the emergency plan
- Schedule (construction and testing)
- Radioactive waste management
- Management system (QAP)
- Creation of a design authority (INSAG-19)

DESIGN REPORT (SITE, IMPACT ON ADJACENT FACILITIES)

- The design information has been defined by ARN,
- The design report have a similar format as a preliminary/final safety analysis report (PSAR/FSAR) but adapted to the current prototype and the content might depend on the authorization step.
- ARN defined the content using:
 - Argentinean standards
 - US RG 1.70
 - IAEA Safety Guide No. GS-G-4.1

AUTHORIZATION FOR FUEL LOAD

To get the authorization for fuel load, the licensee has to submit the following documentation:

- Complete detailed engineering
- Approval of eventual design changes
- Systems release authorization
- Pressure test with dummies (results and test analysis)
- Complete the relevant safety-issues (see next slides)
- Information for eventual decommissioning

AUTHORIZATION FOR FUEL LOAD (cont.)

Relevant safety issues:

- Qualification of the fuel fabrication process
- V&V of neutronic and thermo-hydraulic design
- Accident analysis
- Verification of the integrity of the containment in accident conditions
- Analysis of radionuclide transport mechanisms
- Nuclear and radiological safety during core replacement
- Qualification of the steam generator
- Qualification of the safety systems
- Qualification of the control and safety logic
- Qualification of I&C systems

AUTHORIZATION FOR FUEL LOAD (Cont.)

Information about safety of the facility containing (cont.):

- PSA
- Training of operators
- Commissioning and power tests programs
- Creation of Ad-hoc Committee (technical support group for decision-making on commissioning)

AUTHORIZATION TO PERFORM SUBCRITICAL CORE TESTS

List of relevant documentation:

- Detailed program of tests
- Conditions and acceptances criteria
- Ad-hoc Committee agreement.

AUTHORIZATION FOR FIRST CRITICALITY

List of relevant documentation:

- Ad-hoc committee agreement
- Procedures and test plans
- Updated accident analysis and PSA
- Final emergency plan
- Operation manuals for abnormal event
- Accomplishment of any additional regulatory requirement

AUTHORIZATION FOR ZERO POWER TESTS & POWER INCREASE

List of relevant documentation:

- Ad-hoc committee agreement
- Procedures and test plans
- Complete and update operation manual
- Accomplishment of any additional regulatory requirement

AUTHORIZATION FOR FULL POWER TESTS

List of relevant documentation:

- Complete mandatory documentation (FSAR)
- Radiological aspects during operation
- In-service inspections programs
- RPV surveillance program
- Maintenance, testing and inspections of the safety systems

LICENSING CURRENT STATUS

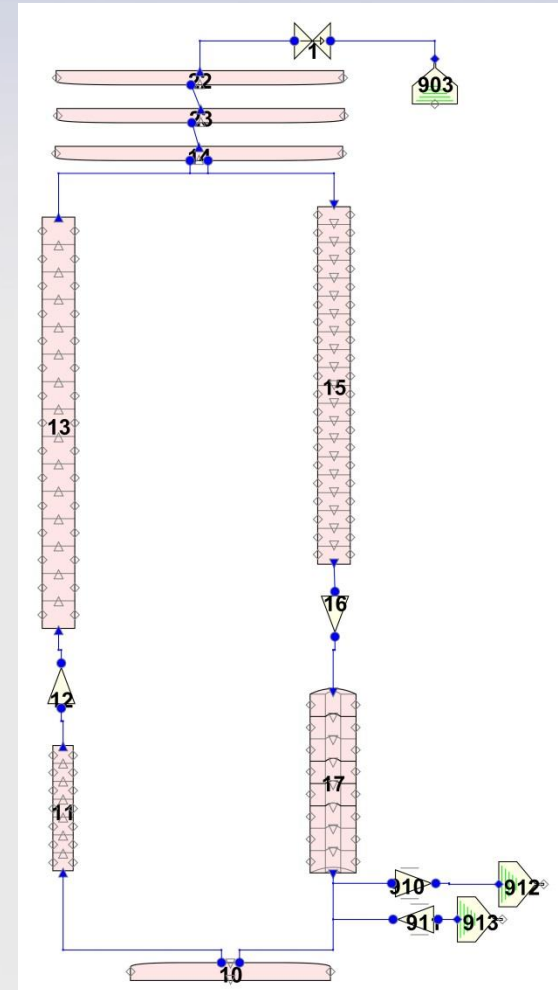
- CAREM25 is being licensee in the frame of a “non-routine practice”.
- CNEA has submitted to ARN the mandatory documentation for getting the Authorization for sitting and construction since 2010.
- The documentation has been reviewed and a set of high level recommendations were given.

LICENSING CURRENT STATUS

- The recommendations were categorized regarding its impact on nuclear building module and safety and safety-related systems design.
- A set of low level recommendations were also addressed.
- In 2013, CAREM25 has received an Authorization for Site Use and Construction. Some additional issues are being addressing.

REGULATORY ACTIVITIES

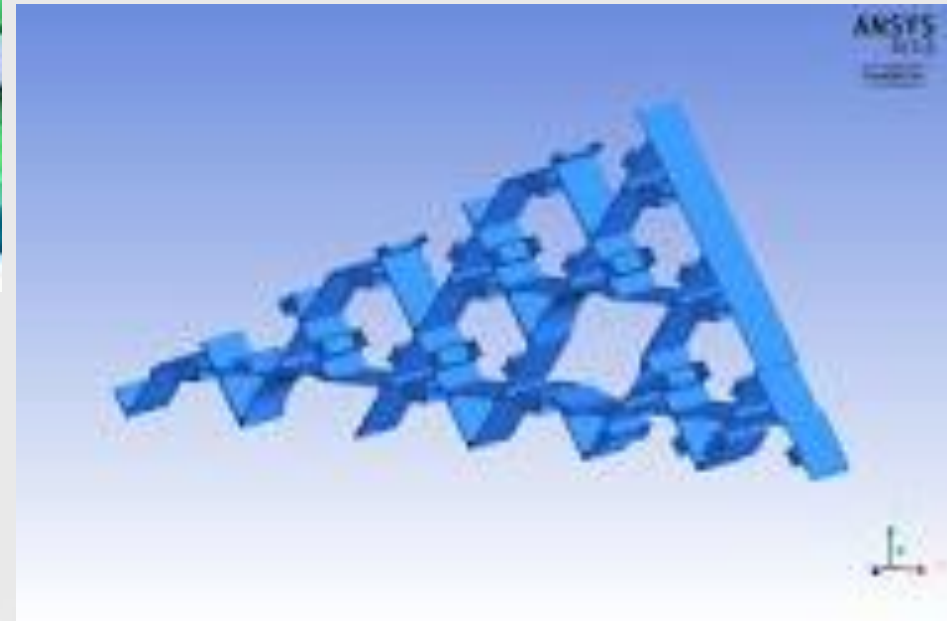
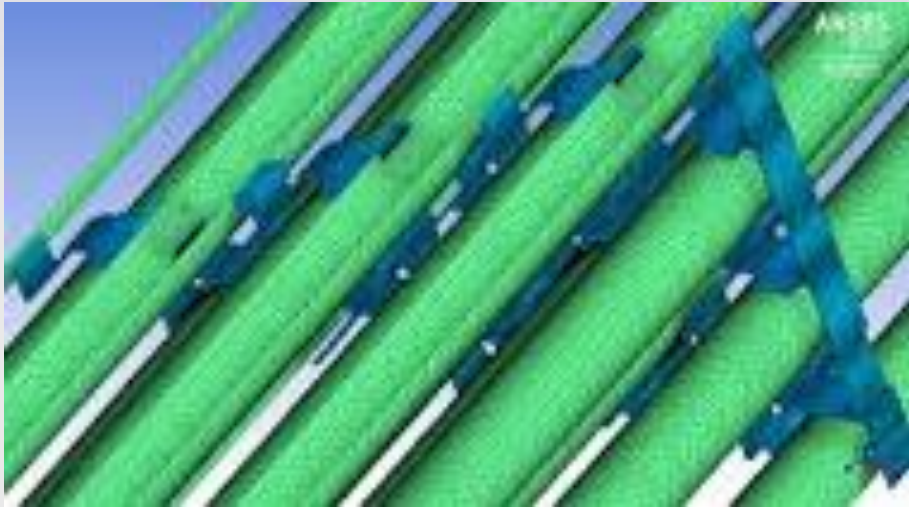
- ARN increased (50 %) full-time working team (for CAREM25) in the last two years.
- ARN staff participated in several CAREM25 training workshops.
- Simple models have been built with a system code for educational/training purposes.
- ARN will start independent safety analysis calculations with a system code. ARN will also contracts national technical support for this task.



Snapshot of CAREM25 simple model

REGULATORY ACTIVITIES

- ARN has been performing a few independent calculations for CAREM25 fuel assembly space grids pressure drop.



From a paper to be presented in a National congress on numerical methods.

“CALCULATION OF PRESSURE DROP IN A PRELIMINARY DESIGN OF NUCLEAR FUEL SPACER GRIDS IN AN INTEGRAL PWR USING CFD METHODS”

J.D. Jiménez Díaz, A.I. Lazarte and J.C. Ferreri

CURRENT ACTIVITIES ON-SITE

- ARN performs weekly on-sites walk down following construction.



FINAL REMARKS

- The traditional licensing scheme has been modified to be applied for CAREM25,
- Mandatory documentation needed to the Authorization for Site Use and Construction has been addressed by CNEA and has been reviewed by ARN,
- Currently (2013), a site use and construction authorization has been given.

**Thank you for attending
and
for your attention**

**Obrigado pela sua atenção
Gracias por su atención**

