RESEARCH REACTORS IN ARGENTINA

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1. INTRODUCTION

Argentine Nuclear Development started in early fifties. Initially oriented to research in nuclear physics, radiochemical studies, material science among others subjects.

In 1957, it was decided to built a research reactor, the first in Argentina. RA-1 reactor (120 kw, today licensed to work at 40 kW) started to work in January 1958. It was the first nuclear reactor to be put in service in South America. Originally RA-1 was an Argonaut (American design) reactor.

2. A short History of the Argentine Research Reactors

In early sixties, the RA-1 core was changed. Fuel rods (20% enrichment) was introduced instead the old Argonaut core design. For that reason, a critical facility named RA-0 was built, initially installed in Buenos Aires. After RA-1 core was changed, RA-0 was moved to Cordoba National University.

After that, the RA-3 project started, to build a multipurpose 5 MW nuclear reactor MTR pool type, to produce radioisotopes and research. For that reason and to define the characteristics of the RA-3 core, another critical facility was built, RA-2. Initially RA-3 was a 90 % enriched fuel reactor, and started operation in 1967.

When started Atucha I Power Plant project , a German design Power Reactor, an small homogeneous reactor was donated for the German Government to Argentina (1969). This reactor was named RA-4 (20% enrichment, 1W) and now is located in the Rosario National University .

In 1982, RA-6 pool reactor was put critical. This reactor, 500 kW and 90% enrichment MTR fuel elements, is located in Centro Atómico Bariloche, and originally was oriented to training and education for the Nuclear Engineering career.

In 1990, RA-3 started to operate fueled by 20% enriched fuel.

In 1997, the RA-8 (multipurpose critical facility located at Pilcaniyeu) started to operate.

3. Argentine Research Reactors development

RA-3 is the most important CNEA reactor. Despite is a foreign design reactor, it was build for argentine technicians and industry, in such a way that our country learned and gained experience in research reactors construction. Certainly, RA-3 is the first of a succession of argentine MTR reactors built by CNEA (and INVAP SE) in Argentina and another countries: RA-6 (500 kW, Bariloche-Argentina), RP-10 (10MW, Peru), NUR (500 kW, Argel), MPR (22 MW,Egypt).

The experience of Argentina Industry permits to compete with foreign developed countries as supplier of research reactors.

4. Research Reactors in Argentina

Today, CNEA has six research reactors whose activities have a range from Education and Promotion of nuclear activity, to Radioisotope Production.

Their characteristics are:

RA0:

Location: Córdoba National University
Power: 1 W (Critical facility)
Fuel Elements: Rod fuel elements
Enrichment: 20%
Moderator: H_2O
Neutron Flux (Max): 10^7 n/cm^2.seg
Irradiation Facilities: Central and External Reflector
Control Rods: Cd cladded in stainless steel (4)
Safety Actions: Rod Insertion, Moderator drainage.
Utilization: Promotion, Education and Training and Fundamental Research

RA1:

Location: Constituyentes Atomic Center (San Martin -Buenos Aires)
Power: Licensed 40 kW, (Designed 120 kW)
Fuel Elements: Rod fuel elements
Enrichment: 20%
Moderator and coolant: H_2O
Neutron Flux (Max): $2\ 10^{12}$ n/cm^2.seg
Irradiation Facilities: Central and External Reflector, Thermal and fast beams
Control Rods: Cd cladded in stainless steel (4)
Safety Actions: Rod Insertion
Utilization: Fundamental Research, Activation Analysis, biological experiments, Material test Irradiations

RA-3

Location: Ezeiza Atomic Center (Ezeiza -Buenos Aires)
Power: 5 MW (to be increased to 10 MW)
Fuel Elements: MTR type
Enrichment: 20%
Moderator and coolant: H_2O
Neutron Flux (Max): $1\ 10^{14}$ n/cm^2.seg
Irradiation Facilities: 6 irradiation boxes, 4 beam horizontal holes (1 tangent) and a Thermal column beam
Control Rods: Ag-In-Cd (4)
Safety Actions: Rod Insertion
Utilization: Production of radioisotopes, Irradiation Test of materials, Activation Analysis, Neutron Radiography, Experimental Production of silicon semiconductor, gems enhancement .

RA-4

Location: Rosario National University (Rosario - Santa Fe)
Power: 1 W (critical facility)
Homogeneous Core: Uranium dispersed in Polyethylene Disks
Enrichment: 20%
Moderator: Polyethylene
Neutron Flux (Max): 10^7 n/cm^2.seg
Irradiation Facilities: beam horizontal holes (1 tangent) and a Thermal column beam, 2 beam vertical holes
Control Rods: Cd and Al (2)
Safety Actions: Rod Insertion and Core Decoupling
Utilization: Promotion, Education and Training and Fundamental Research

RA-6

Location: Bariloche Atomic Center (Bariloche- Río Negro)
Power: 500 kW
Fuel Elements: MTR
Enrichment: 90%
Moderator and coolant: H_2O
Neutron Flux (Max): $1\ 10^{13}$ n/cm^2.seg
Irradiation Facilities: 5 beam horizontal holes and a Thermal column beam, epithermal BNCT facility
Control Rods :Cd (4)
Safety Actions: Rod Insertion
Utilization: Education and Training, Fundamental Research, Activation Analysis, Neutron Radiography, clinical BNCT, Experimental Production of silicon semiconductor.

RA-8

Location: Technological Pilcaniyeu Center (Pilcaniyeu -Rio Negro)
Power: 10 W (critical facility)
Fuel Elements: UO_2 pellets with Zy4 clad
Enrichment: 1.8 % and 3.6 %
Moderator and coolant: H_2O
Neutron Flux (Max): $1\ 10^8$ n/cm^2.seg
Control Rods: Bare In-Ag-Cd
Safety Actions: Rod Insertion
Utilization: Multi – purpose critical facility

5. Future Objetives:

Development of the potential of Argentine Research Reactors are the priority of the Reactors Program with respect of this field.

At this moment, RA-3 upgrade is the most important project. A 10 MW RA-3 is important not only from the radioisotope Production point of view, but from the beam research potential. In fact, one of the plans the Argentine Research Reactor program has is to develop the beams of RA-3. Nevertheless, RA-6, and RA-1 are very important because the gives the possibility to test devices and methods to be implemented in RA-3. For instance, for Silicon Semiconductor Production, or Gems enhancement.

By other hand, in RA-6 will be the clinical BNCT epithermal facility. In RA-1 there is an experimental biological facility. Both reactors, RA-6 and RA-1, they can be used as alternatives for the productions of some radioisotopes.

The Research Reactor Program permits that Human Resources in the Argentine Reactors work together for each objective, despite the geographical distances between the facilities. This is clear in items such as documentation, regulatory aspects, etc.

6. Conclusions

For more than forty years, argentine Research Reactors are working. The experience of Argentine is important, and argentine firms are able to compete in the design and construction of new research reactors in the world.