



Research Reactors in and from Argentina

Presentation to IAEA's International Conference on
Research Reactors

Rabat, 16 November 2011

INVAP

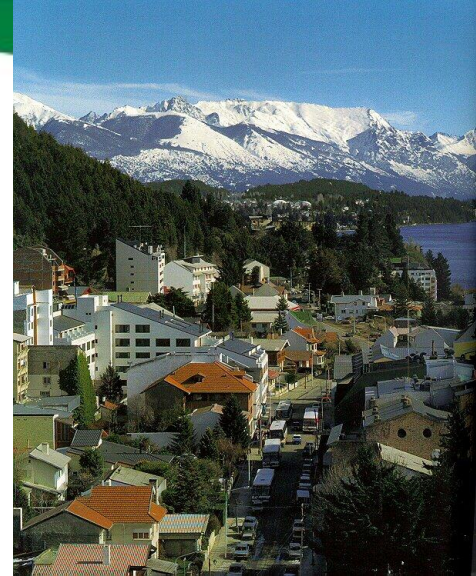
Milestones in Nuclear Technology in Argentina

- **Late 40's** **Nuclear activity started in Bariloche**
- **1950** **Atomic Energy Commission Founded**
- **1958** **RA-1: First Research Reactor**
- **1974** **Atucha 1: First NPP in Latin America**
- **1978** **RP- 0: First Research Reactor Export**
- **1983** **Pilcaniyeu: Uranium Enrichment Technology**
- **1984** **Embalse: Second Nuclear Power Plant**
- **2006** **Atucha 2 and CAREM project relaunched**



The Company

- Created September 1st, 1976
- State owned - Province of Rio Negro
- Operations no different to a public listed company
- Annual Sales: 200 Million USD
- Backlog: More than 700 Million USD
- 900 employees (85% Professionals and Technicians)
- Close cooperation with Atomic Energy Commission (CNEA)
- A subsidiary in USA, and branches in Australia, Brazil, Egypt and Venezuela



Fields of Activity

- **Nuclear:**
 - **Research reactors and associated facilities**
 - **Services to Nuclear Power Plants**
 - **Engineering services to nuclear industry**
 - **Waste management plants**
 - **Independent Technical Advisor to Regulatory Bodies**
- **Aerospace (Satellites)**
- **Defence (Radars)**
- **Communications (Digital TV, Optic fibre)**

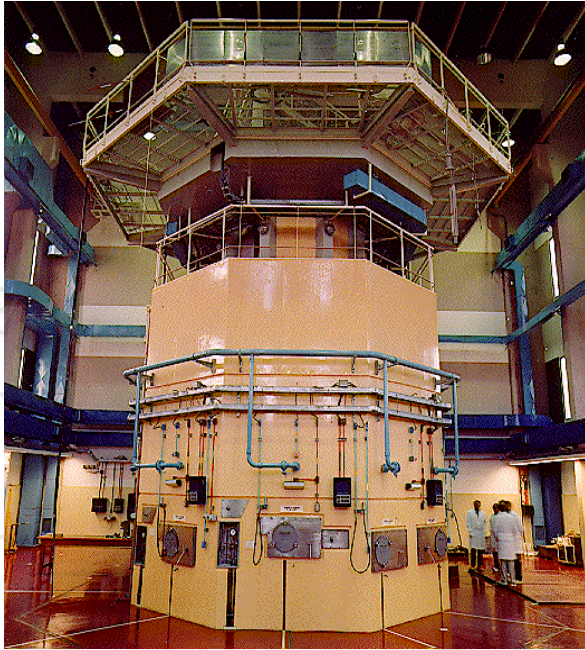
Milestones for Research Reactors

- 1958 RA-1: First Research Reactor
- 1965 RA-0: Critical facility
- 1966 RA-2: Critical facility
- 1968 RA-3: Radioisotope production reactor
- 1972 RA-2: Homogeneous critical facility
- 1978 RP-0: Critical facility in Peru
- 1982 RA-6: Research and training reactor
- 1988 RP-10: Multipurpose reactor in Peru
- 1989 NUR: Research and training in Argelia
- 1997 RA-8: Carem critical facility
- 1998 ETRR-2: Multipurpose reactor in Egypt
- 2006 OPAL: Beam and RP reactor in Australia

Milestones for RR related projects (only exports)

- **1993** Refurbishment and conversion from HEU to LEU of Teheran reactor in Iran
- **1994** Radioisotope production plant in Cuba
- **1998** Fuel element manufacturing plant in Egypt
- **2000** Fuel element manufacturing plant in Algeria
- **2009** Mo-99 production plant in Australia
- **2009** Refurbishment of I&C for Pitesti reactor in Rumania
- **2011** Radioisotope production plant in Egypt
- **2011** Refurbishment of I&C for Tajoura reactor in Libya

Nuclear Division: the beginning



The first reactor: RA6
1978-1982



The Pilcaniyeu Complex:
Mastering the process of U enrichment
1978-1983

GASSEOUS DIFUSION

RA-6 Research Reactor

Location: Bariloche Atomic Centre

Use: training, basic research, neutron activation analysis, neutron radiography, clinical BNCT, silicon doping

Main characteristics: 500 kW, pool type, MTR fuel, H₂O

In operation since 1982



NUR Research Reactor

Location: Alger (Algeria)

Use: training, basic research, neutron activation analysis, neutron radiography,

Main characteristics:

1000 kW, pool type, MTR fuel, H₂O

In operation since 1989



ETR-2 Multipurpose Reactor (Egypt)

Power = 22 MW

Operating since 1998

Radioisotope Production, R&D,
Training, Industrial Services,
Materials Testing



ETRR-2 Multipurpose Reactor (Egypt)

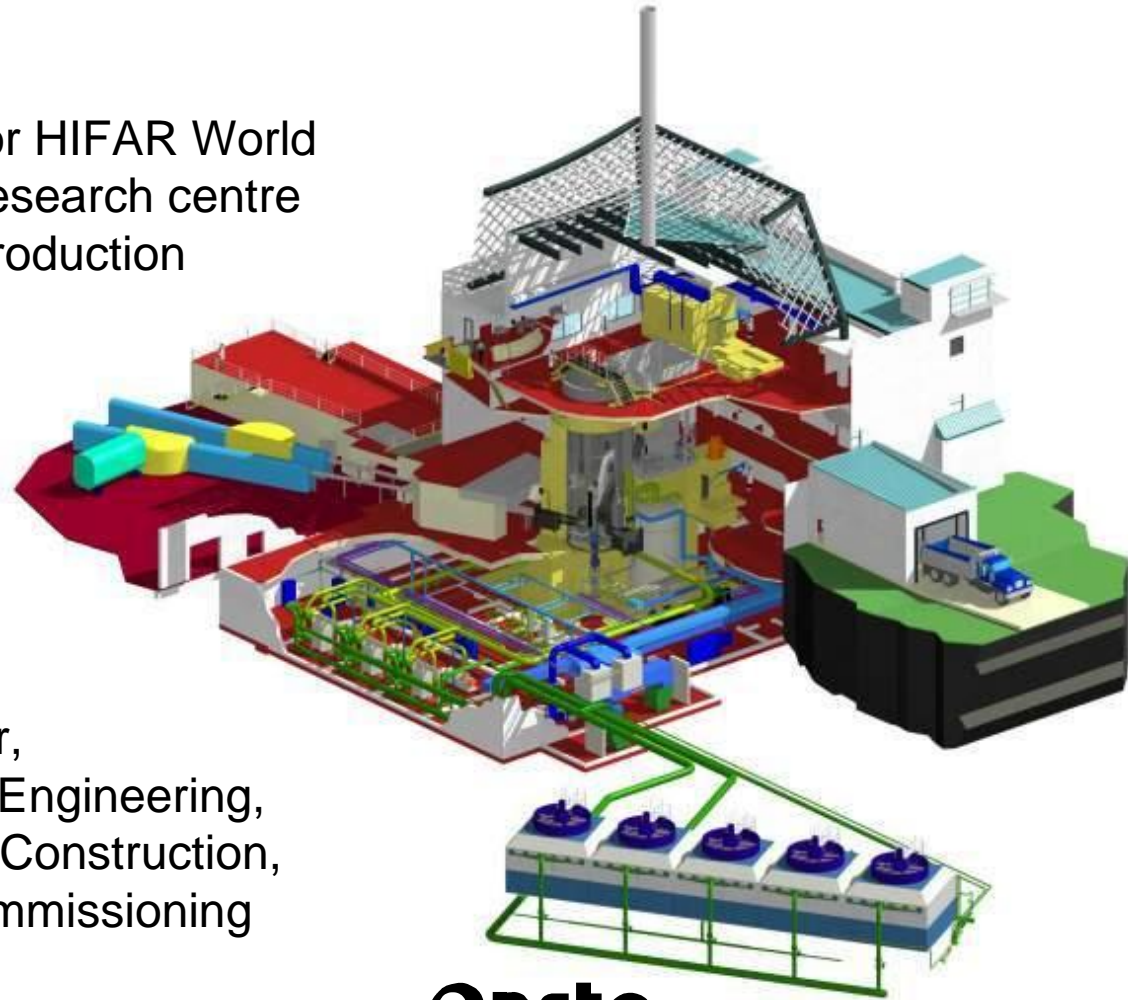
February 1991: Tender submission
September 1992: Contract signed
March 1993: Civil Works
December 1995: Tank Installation
September 1996: Clean Reactor Hall
September 1997: Commissioning
March 11, 1998: Full Power



Australia - OPAL Project

- **ANSTO:** Replacement for HIFAR World class neutron research centre
Radioisotope production

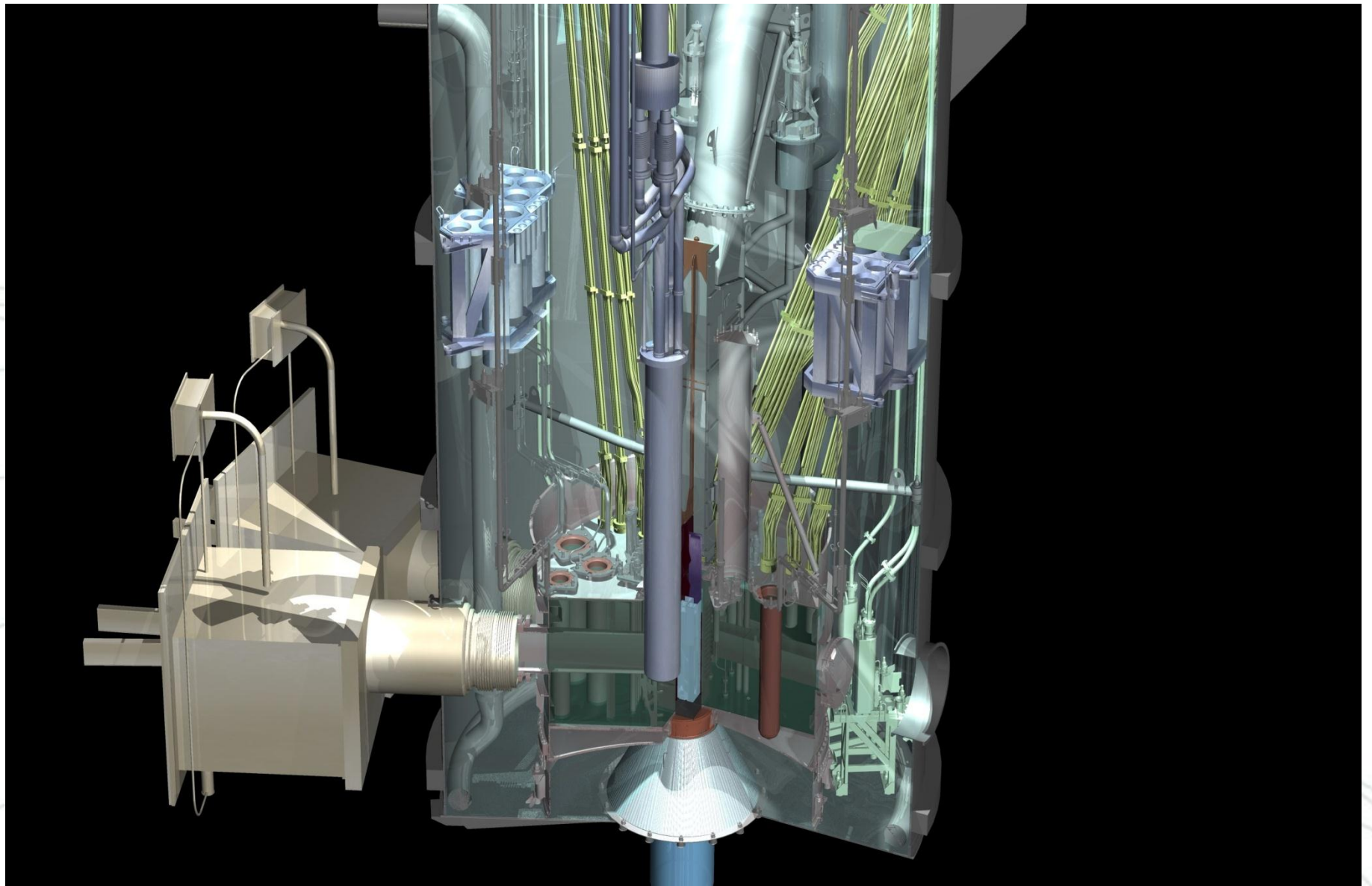
- **INVAP:** Main Contractor,
responsible for Engineering,
Manufacturing, Construction,
Installation, Commissioning



Ansto



INVAP

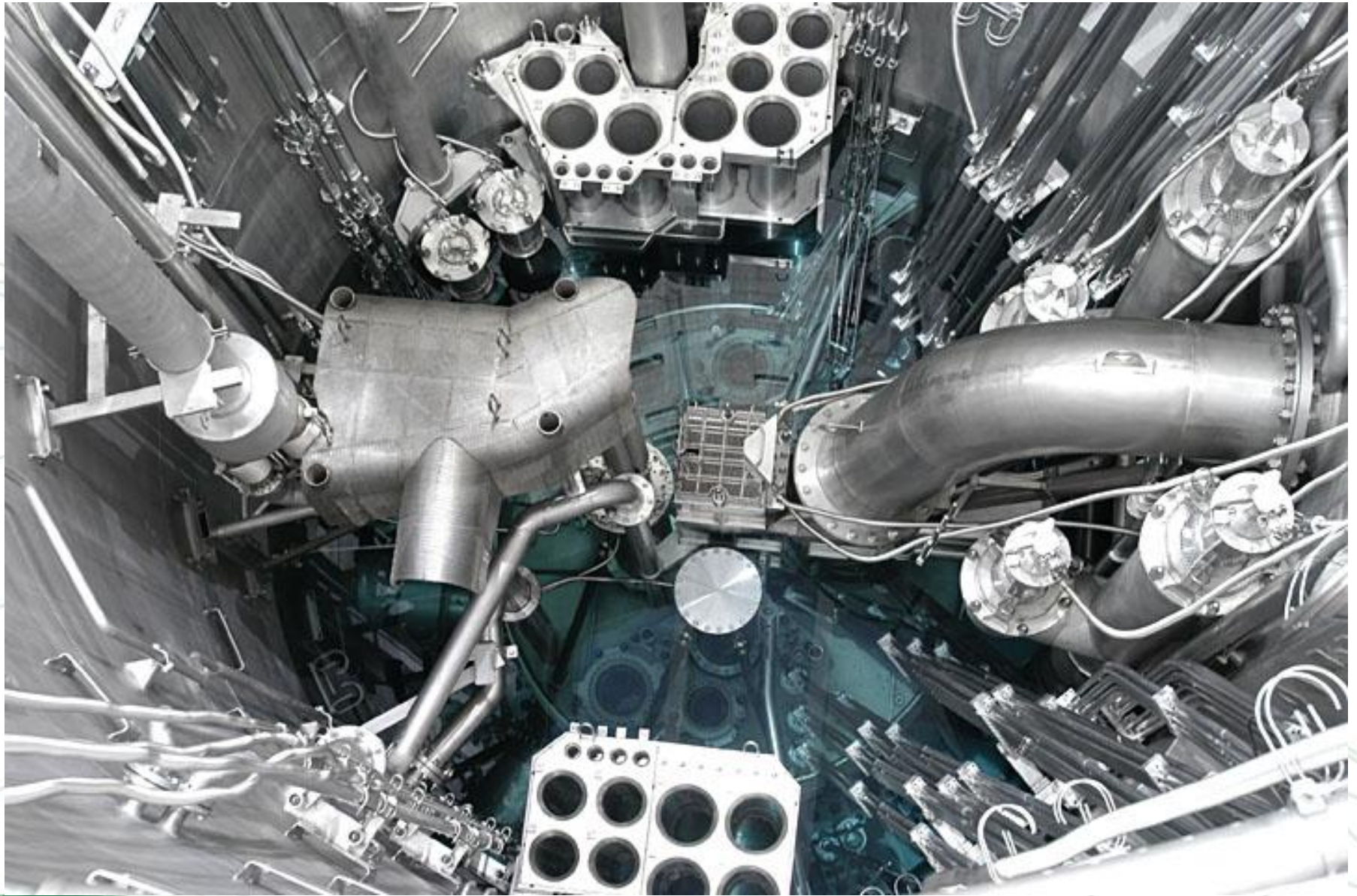


Safety & Licensing

- Australian and IAEA regulations and standards
- Deterministic & Probabilistic analyses
- Comprehensive PSAR & PSA
- Review:
 - ANSTO staff
 - ARPANSA (Regulatory Body) staff and consultants
 - Argentine Regulatory Body
 - IAEA Peer Review Team
 - Public, and NGO consultants

We have worked with regulatory bodies of many countries

First Water in the Pool!!! November 2005

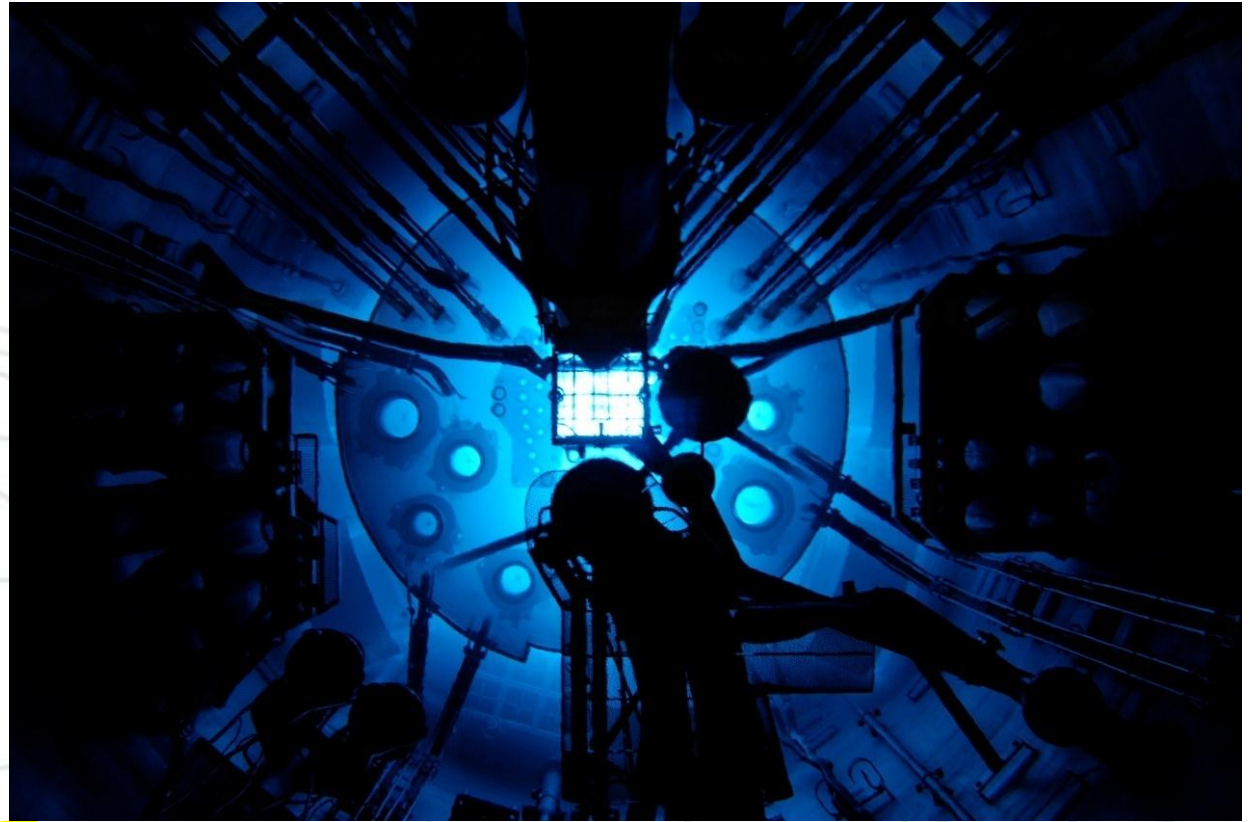


First Criticality!!!!



August 12, 2006

First Full Power!!!!

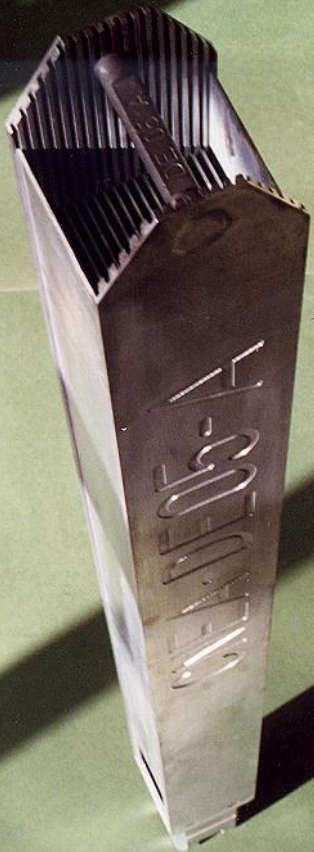


November 3, 2006

Fuel Element Manufacturing Plants

- MTR type fuel manufacturing plant for Algeria
- MTR type fuel manufacturing plant for Egypt

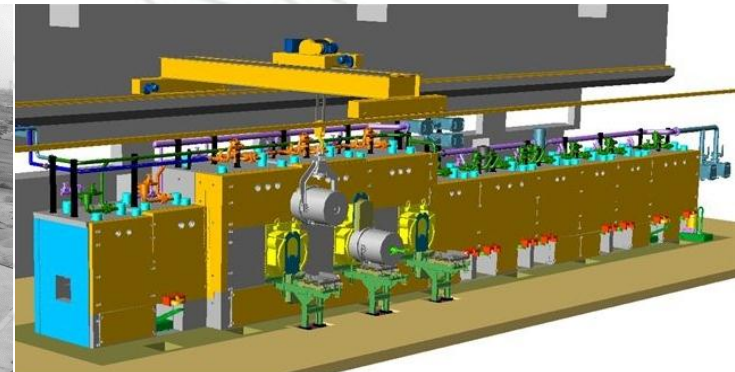
CNEA is a world accredited supplier of
MTR fuel



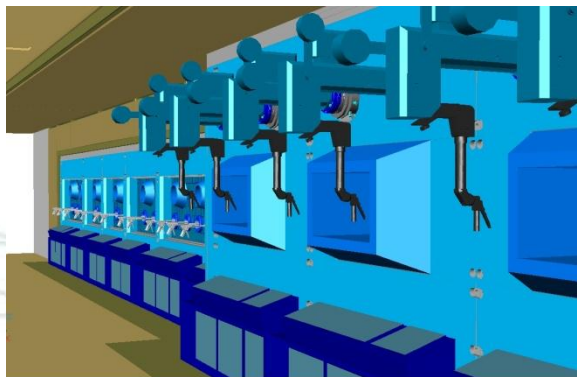
Radioisotope Production Plants

- Radioisotope Production Plant for Cuba
- Radioisotope Production Plant for Egypt
- Moly Production Plant for Australia

CNEA is an internationally certified radioisotope producer and has developed various radioisotope production techniques and processes.



Mo 99: Design, Construction & Commissioning of Radioisotopes Production Plants

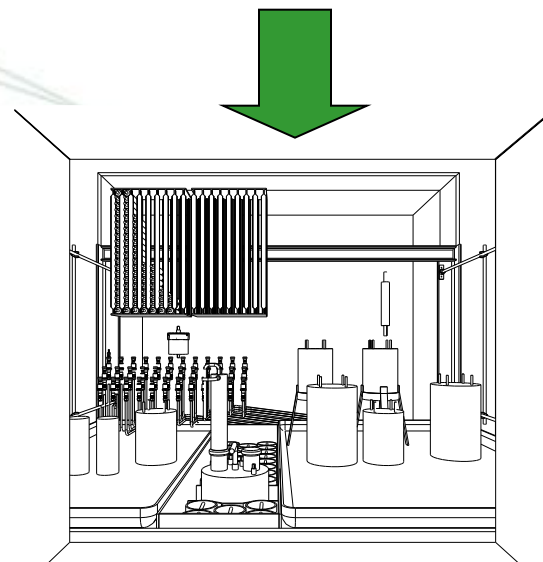


Radioisotopes Production Facility (EGYPT)

All LEU based



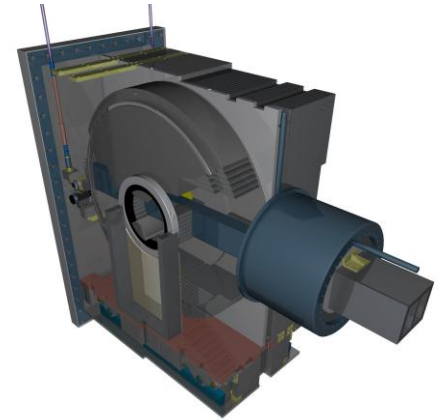
MOLY PROJECT (AUSTRALIA)



LEU MO-99 TARGET AND PROCESS SYSTEM

Special Components

- Control Rod Drives
- Pool internal components (including Reflector Vessel)
- Special Purpose Equipment
 - Automatic Welding Device
 - Cold Neutron Sources (with PNPI)
 - Primary Shutters



Instrumentation and Control

- Complete Reactor Protection Systems
- Complete Reactor Control and Monitoring Systems
- Special instruments:

Radiation
Monitoring
Instruments

Neutron
Instruments
(with CNEA)



Our (INVAP/CNEA) export record in the RR field:

All LEU based

5 Reactors

3 Radioisotope Production Plants

2 Fuel Manufacturing Plants

3 Research Reactor Refurbishments

13 facilities in the past 30 years

What is going on now

- ***Opal is operating very reliably:
950 full power days in first five years
more than 280 fpd in both 2010 and 2011***
- ***Last month we (INVAP/CNEA/B&W) produced our first Ci on Mo-99 from the AHRE, a subcritical loop in the RA-6 reactor in Bariloche***
- ***Last month we (INVAP/CNEA/AEA) started up the Mo-99 production plant in Egypt.***

More research reactor are needed!

- Research reactors are very useful tools:

Training

Radioisotope production

Science

Nuclear & material development

.....and they are coming!

There are more new research reactors projects now than ever before in the last three decades.

However, the resources are limited

The total market for new research reactors for the next two decades is smaller than.....

One nuclear power plant!

What will these reactors be for?

Training

Radioisotope production

Science

Irradiation

Multipurpose

What will these reactors look like?

Pool reactors

LEU

Plate type fuel

Innovation within these boundaries



Thank you!

Juan Pablo Ordóñez jordonez@invap.com.ar