

EUD ] IOIDQ UHVHDFK  
UHD FWR UV

**Clédola Cássia Oliveira de Tello**

**Pablo Andrade Grossi**

**Centro de Desenvolvimento da Tecnologia Nuclear  
(Nuclear Technology Development Center)  
CDTN/CNEN**

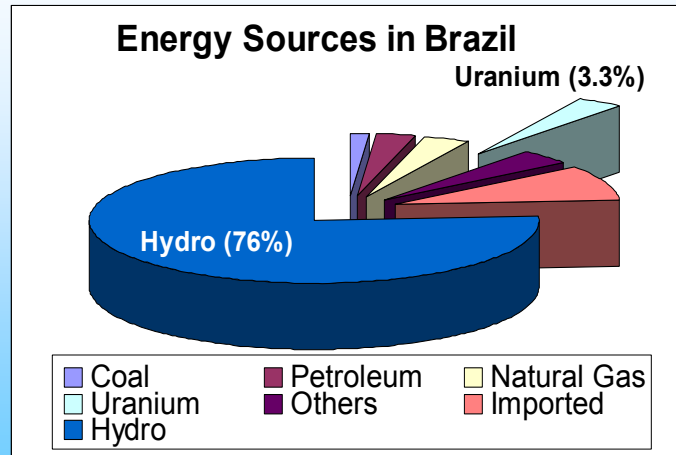
**Workshop on the Basics of the Decommissioning of Research Reactors (R2D2P)  
Manila, 16 - 20 October 2006**

EUD ] IO



- THE LARGEST COUNTRY  
IN SOUTH AMERICA
- AREA: 8.5M km<sup>2</sup>
- POPULATION: 185 M  
INHABITANTS

## Hqhuj | vrxufhv xvhg lq Eud} lo



## Q X FOHDU SR Z HU SODQ WV

- **ANGRA 1**
  - 600 MW
  - WESTINGHOUSE
  - 1985 - COMMERCIAL OPERATION
- **ANGRA 2**
  - 1300 MW
  - KWU - KRAFTWERK UNION A.G. (SIEMENS)
  - 2000, DEC. - COMMERCIAL OPERATION



Q X F O H D U S R Z H U S O D Q W V

### ANGRA 1



### ANGRA 2



Q X F O H D U S R Z H U S O D Q W V  
D Q J U D 6

- **1300 MW**
- **KWU** - KRAFTWERK UNION AG (SIEMENS)
- **1996** - CONSTRUCTION STARTED
- **2006** - DECISION TO CONTINUE
- **2008** - COMMERCIAL OPERATION



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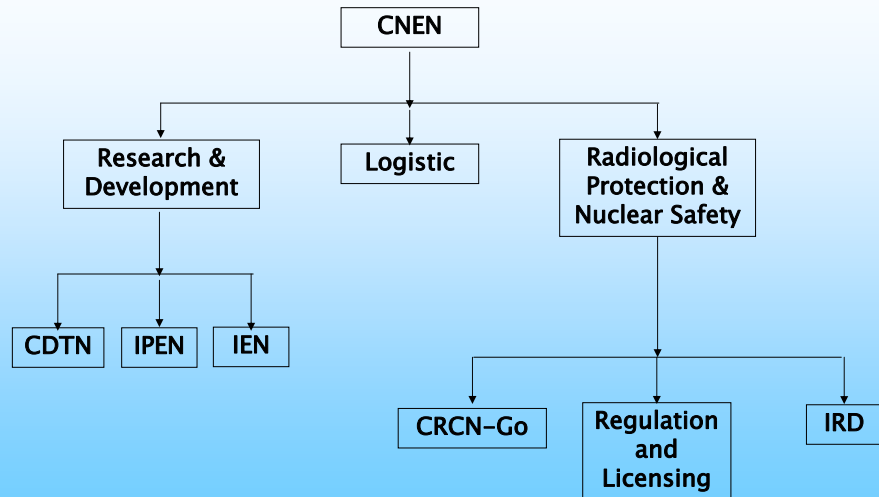
F Q H Q

NDWIR Q DO CR P P IVIR Q R I NX FO HDU  
EQHUJ \

- MINISTRY OF SCIENCES AND TECHNOLOGY
- 10th. OCTOBER, 1956
- RESPONSIBLE FOR:
  - ESTABLISHMENT OF NORMS AND REGULATIONS CONCERNING TO RADIOLOGICAL PROTECTION AND NUCLEAR SAFETY,
  - LICENSING, INSPECTION AND CONTROL OF NUCLEAR ACTIVITIES IN BRAZIL.
- RESEARCH AND DEVELOPMENT IN NUCLEAR TECHNIQUES.



# CNEN - STRUCTURE



## CNEN OFFICES IN BRAZIL



## Q X F O H D U U H V H D U F K U H D F W R U V

- **Four research reactors are operated by the federal research institutes.**

<i>FACILITY</i>	<i>POWER (kW)</i>	<i>TYPE</i>	<i>STATUS</i>
ARGONAUTA	0.20	ARGONAUTA	Oper.
IEA-R1	5,000.00	POOL	Oper.
IPEN-MB 01	0.10	ZPR TANK	Oper.
IPR-R1	250.00	TRIGA-Mark I	Oper.

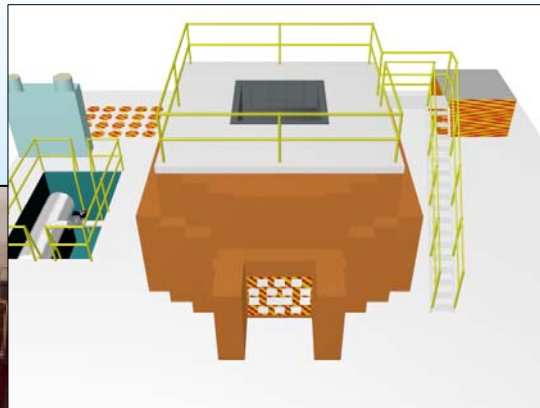


## Q U U O D U J R Q D X W D

- At the ***Institute of Nuclear Engineering*** (Instituto de Engenharia Nuclear – IEN), in ***Rio de Janeiro*** city.
- The first criticality of the reactor was reached on ***February of 1965***.
- The reactor can operate at a maximum power of ***1kW*** during an hour or ***500 W continuously***.
- It is used mainly for ***training purposes, research and sample irradiation***.



## QUU 0DUJR QDXWD



ARGONAUTA Reactor - Frontal View



## QUU 0IHD U4

- ***The oldest in the Southern Hemisphere.***
- At the ***Nuclear and Energetic Research Institute*** (Instituto de Pesquisas Energéticas e Nucleares - IPEN).
- ***US program Atoms for Peace.***
- Operates continuously during 120 hours per week at ***5 MW.***
- Initially it operated with ***high-enriched fuel***, and now it has been converted to ***Low Enriched Uranium*** (LEU).
- It is used, besides the ***research*** purposes, mainly to ***produce radiopharmaceuticals.***

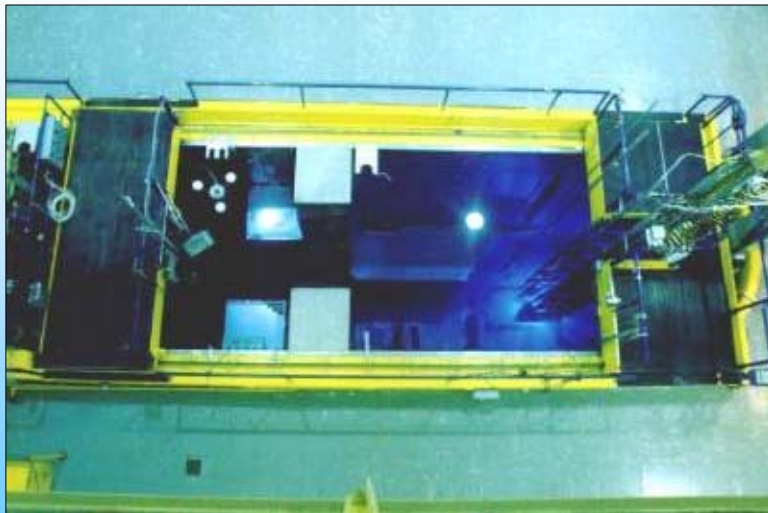


IHD U4



CDT  
CENTRO DE DESARROLLO  
EN TECNOLOGÍA

IHD U4 +s rro,



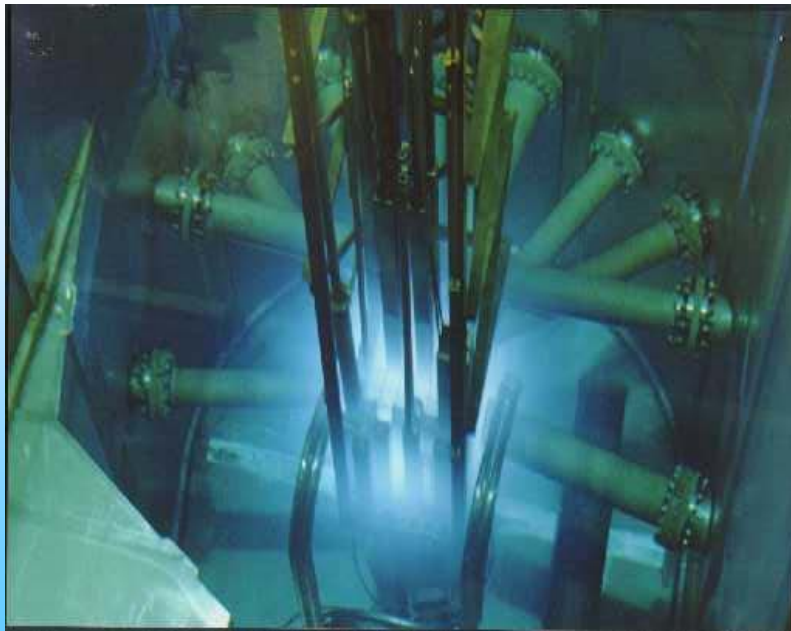
CDT  
CENTRO DE DESARROLLO  
EN TECNOLOGÍA



IHD  $\omega$ 4 +fruh,



IHD  $\omega$ 4 +fruh,



## QUU 01SHQ P E034

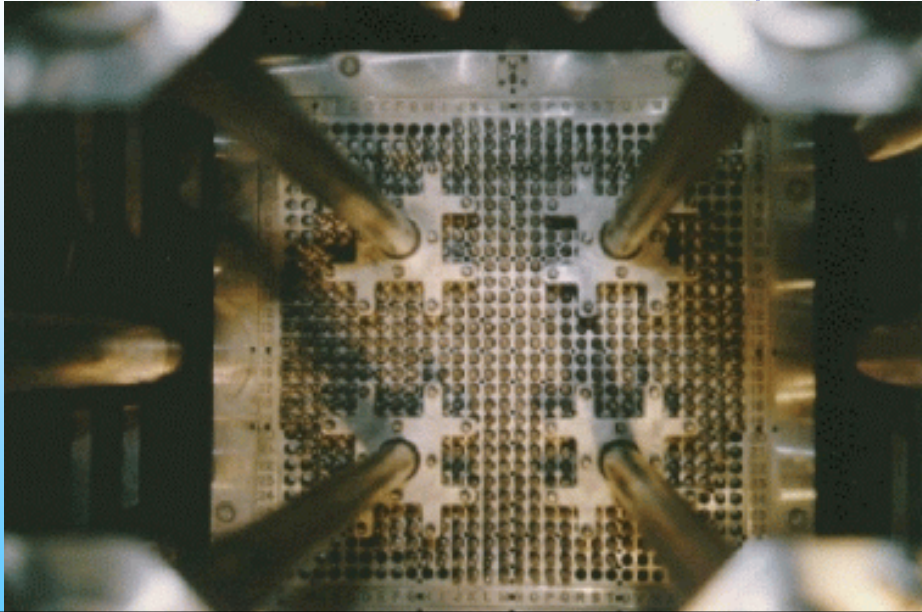
- **The newest Brazilian RR.**
- At the **Nuclear and Energetic Research Institute** (Instituto de Pesquisas Energéticas e Nucleares - IPEN)
- **US program Atoms for Peace.**
- The reactor can operate at **100 W**, and reached criticality for the first time on **November of 1988.**
- It is used for simulation of small **LWR** and **research in reactor physics.**



## ISHQ 2 P E 034



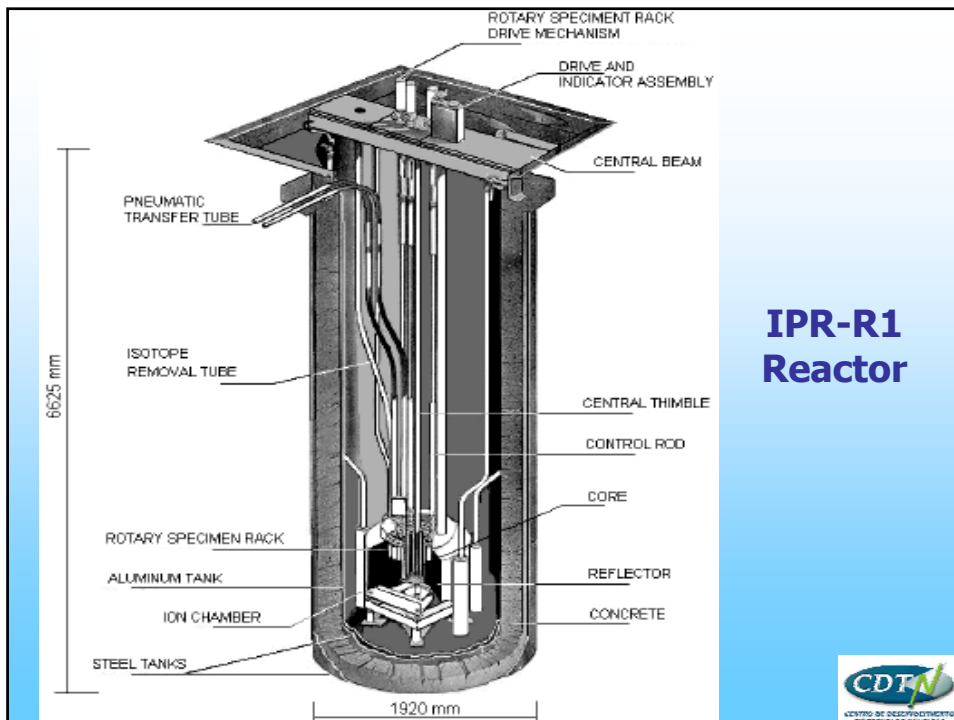
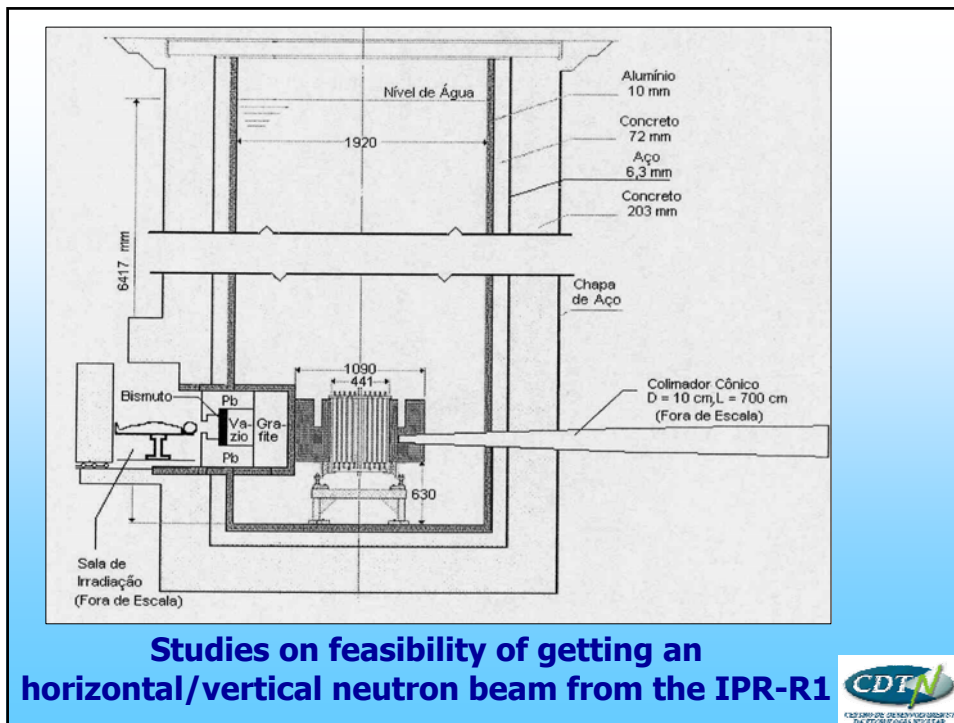
ISHQ 2 P E Û 34 +fruh,

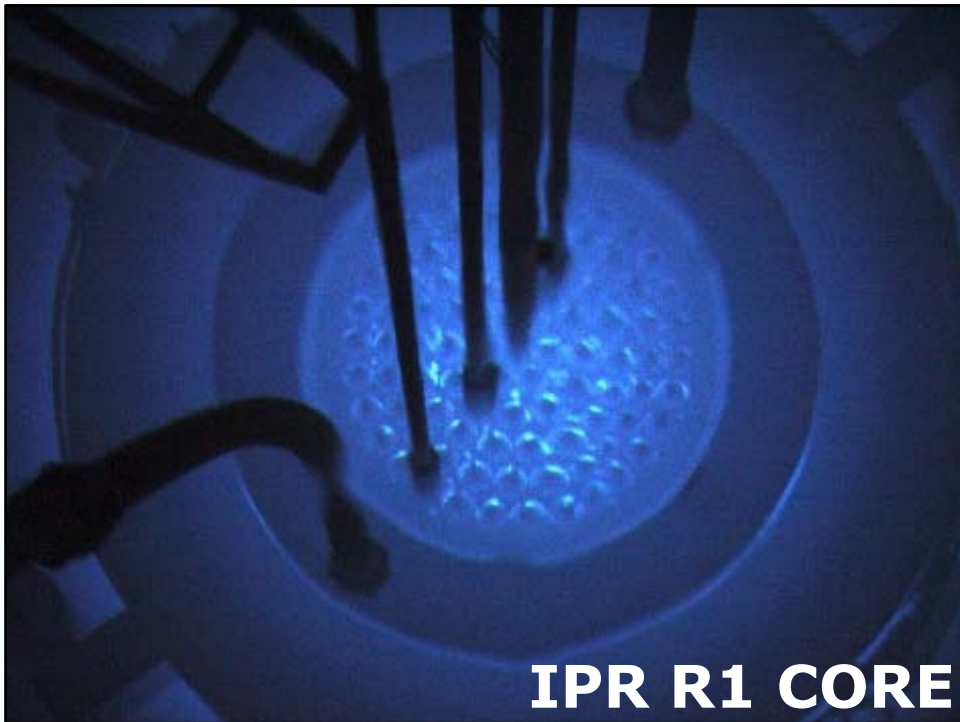


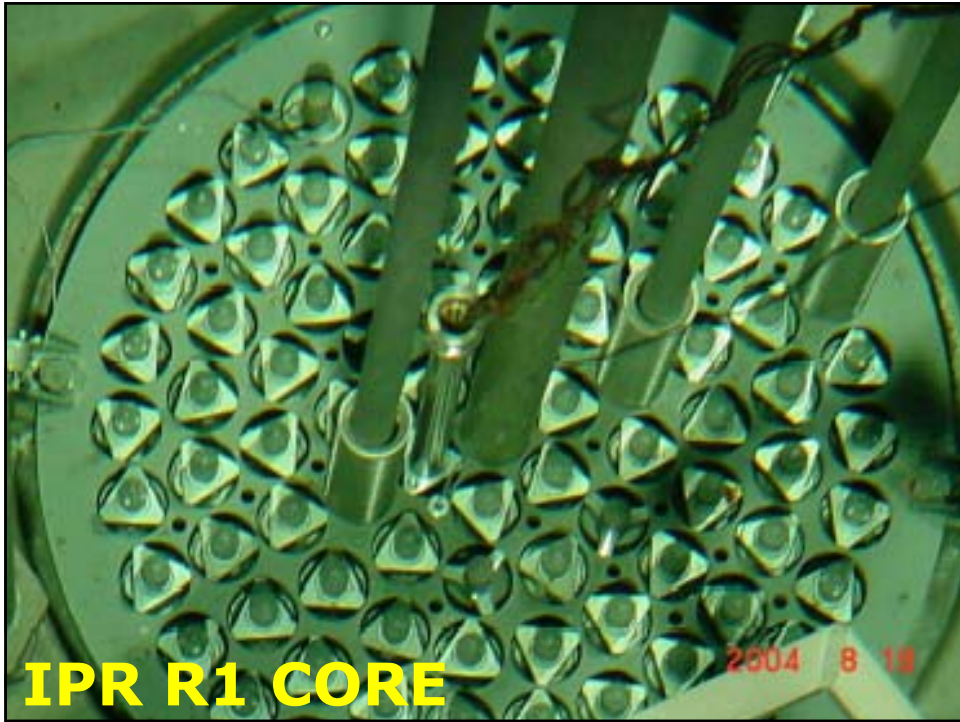
QUU 0ISUW4

- **250 kW Triga reactor.**
- At the **Nuclear Technology Development Center** (Centro de Desenvolvimento de Tecnologia Nuclear - CDTN) in Belo Horizonte.
- The first criticality was achieved on **November of 1960.**
- It operates 4 hours per day, 5 days per week, 40 weeks per year.
- It is mainly used for **research and reactor operators training (Angra I and II).**





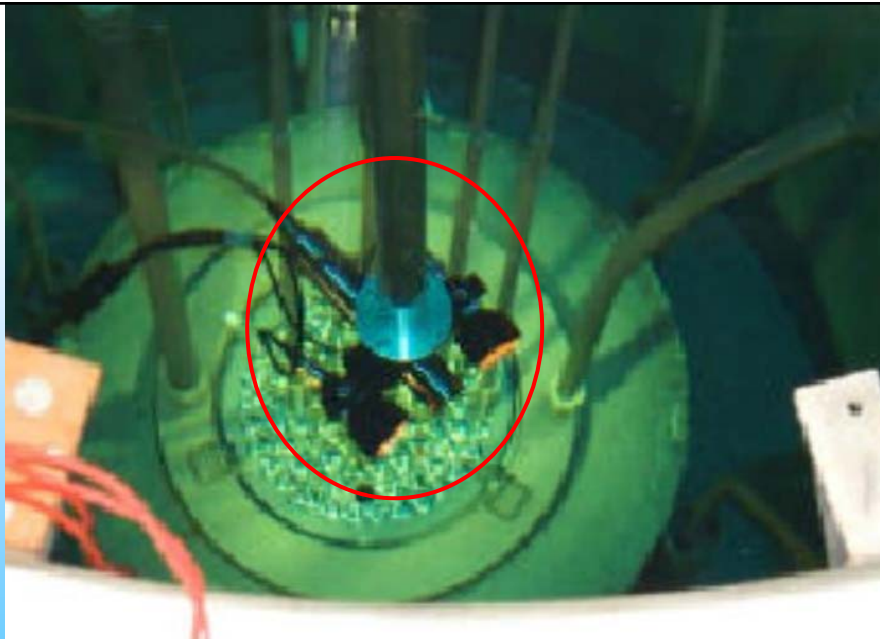




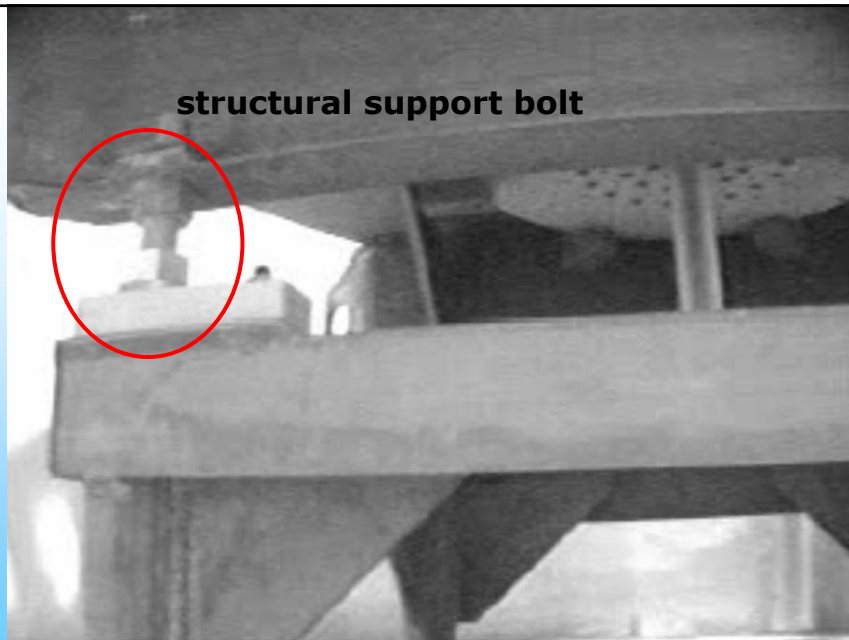
**IPR R1 CORE**

**VISUAL INSPECTION TO  
CHECK THE INTEGRITY  
OF IPR-R1 FUEL RODS**



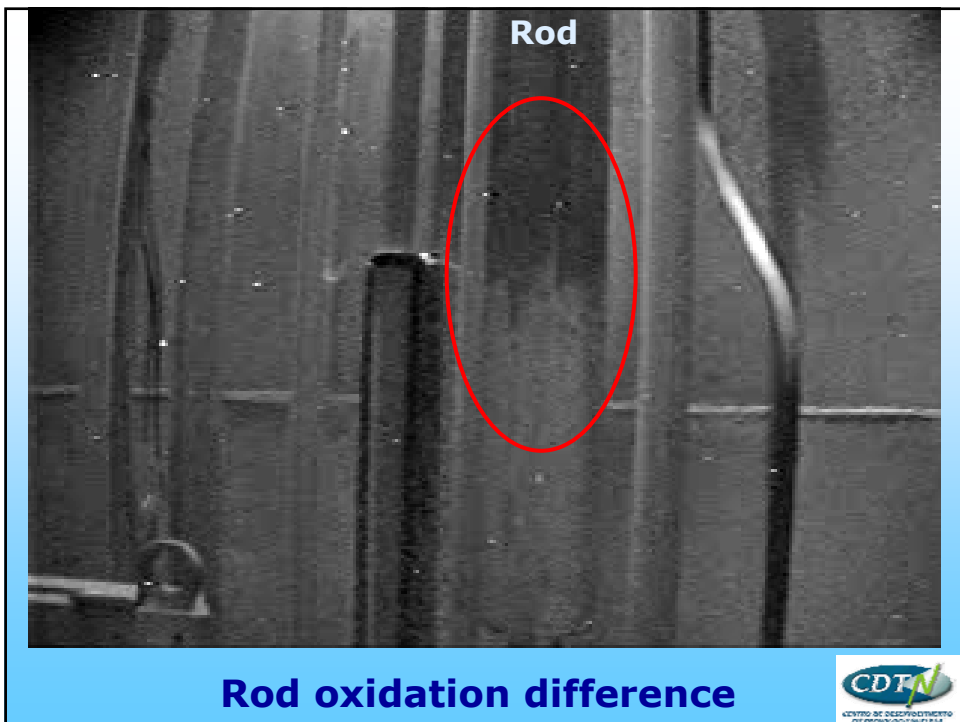
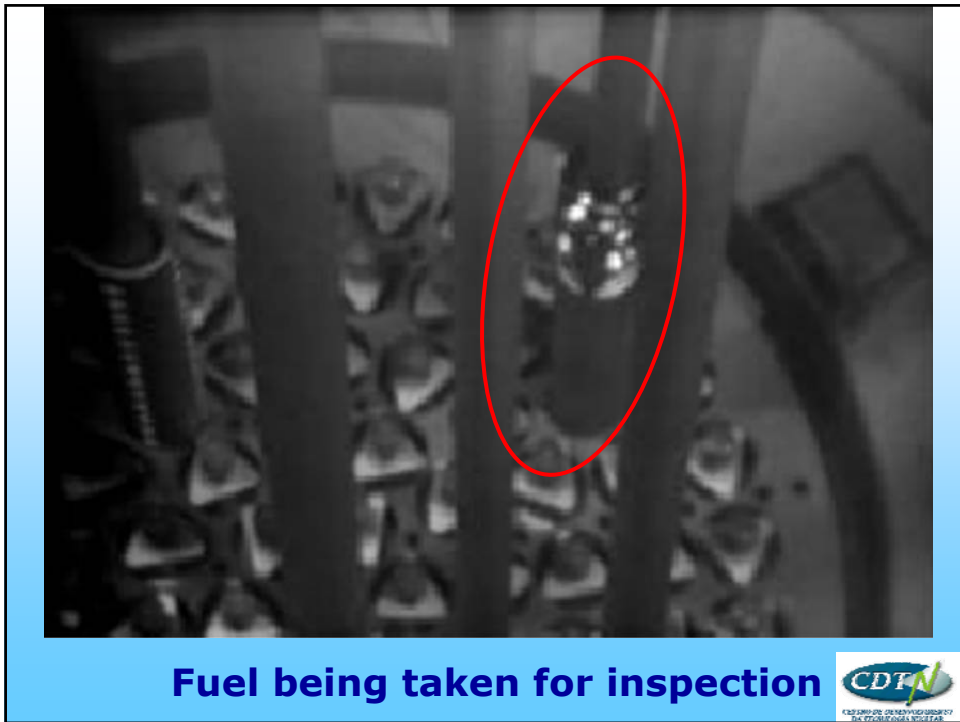


**Camera immersed in to the pool**

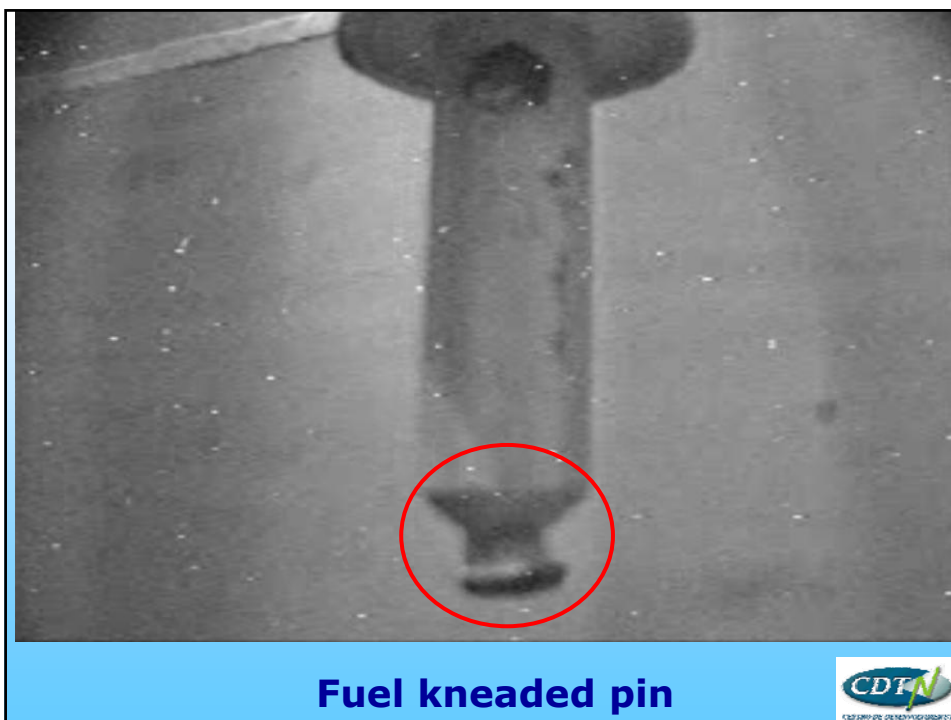


**View of the reactor structure**









G H F R P P I V V I R Q I Q J

- It is part of the Report for licensing
- Decommissioning of mines and one earth-rare industry
- Decommissioning plan for the NPPs will be defined after the decision of the repository
- Decommissioning plan for the RR will be established



## Vshqw IxhoHdhp hqw

- **Spent fuel is not considered radioactive wastes, as defined in the National Report of Brazil for *the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*.**
- **Brazil has not yet defined about the spent fuel and high-level waste disposal.**



## Vshqw IxhoHdhp hqw 0UU

- **IEA-R1 - Part of its spent fuel was returned to USA, in 1999.**
- **Storage facilities at IEA-R1 consist on racks in the reactor pool (capacity of 156 assemblies).**
- **21 storage positions are occupied (7-10 years can be full).**
- **The option to send SFA (Spent Fuel Assembly) to USA will cease, and a national solution will have to be adopted.**



## Vshqw IxhoHdhp hqw 0UU

### IAEA REGIONAL PROJECT – OBJECTIVES

- Provide the basic conditions to define a regional strategy for managing spent fuel;
- Provide solutions taking into consideration the economic and technological reality of the countries involved,
- Determine the basic conditions for managing RR spent fuel during operational and interim storage as well as final disposal,
- Establish forms of regional cooperation for spent fuel characterization, safety, regulation and public communication.



## Vshqw IxhoHdhp hqw 0UU

- **Argonauta and IPR-1**
  - at the moment due to the low nominal power, except for aging concerns, spent fuel is not a problem.
- **IPR-1 - the first fuel assembly replacement of the reactor is expected to occur only in 2010.**



UDGIRDFWIYH Z DVWH  
P DQDJHP HQW

- **Brazilian practices are similar to most international practices.**
- **The policy is to keep them safely isolated from the environment for time being, while a permanent solution is expected on a national level.**



UDGIRDFWIYH Z DVWH  
P DQDJHP HQW

**The basic legislation governing this policy are:**

- **Brazilian Constitution, which establishes in its article 21 that “all the nuclear energy activities shall be solely carried out for peaceful uses and always under the approval of the National Congress”;**
- **Law 6.189, which attributes to CNEN the responsibility for the management of radioactive wastes;**
- **Law n. 10.308 of 20 November 2001, which establishes rules for the siting, licensing operation and regulation of radioactive waste facilities in Brazil;**
- **Brazilian Program for Radioactive Waste Management – under approval.**



## Z DVWH WHFKQRORJ \

- **WASTE MANAGEMENT**
  - RADIOACTIVE WASTES: LLRW AND ILRW
  - HAZARDOUS WASTES (NO RADIOACTIVE)
  - WASTES FROM MEDICAL USES
  - TRAINING
- **MODELLING**
  - SAFETY ASSESSMENT FOR LLRW

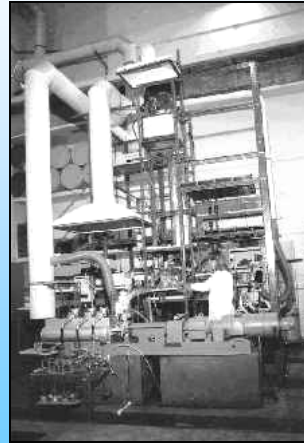


## WASTE TECHNOLOGY FACILITIES

- LIQUID WASTE STORAGE
- INTERIM RADWASTE STORAGE
- CHEMICAL PRECIPITATION FACILITY (200L BATCH PLANT)
- CEMENTATION FACILITY (200 L BATCH PLANT)
- CEMENTATION LABORATORY
- BITUMINIZATION PILOT PLANT
- COMPACTION FACILITY (16 TON COMPACTOR)



## WASTE TECHNOLOGY FACILITIES



**CEMENTATION AND BITUMINIZATION PLANTS**



## WASTE TECHNOLOGY FACILITIES



**CEMENTATION LABORATORY**



VX P P DU \

- 2 nuclear power plants
- 4 research reactors
- 1 repository (Goiania's radiological accident)
- Decommissioning experiences in mines and in an industry
- There aren't any national regulations for decommissioning
- Follows the IAEA's guidelines.



VX P P DU \

**3rd WORLD TRIGA USERS CONFERENCE  
22.8. - 25.8.2006 – Belo Horizonte- MG –  
BRAZIL**

**One of Session Topics:  
-TRIGA Reactor Decommissioning  
(no paper submitted)**



