BRAZIL PRESENTATION

Marco Aurélio LEAL

Head of Technical Support Division

Experience on Creating Confidence

Radioactive Waste Management

Summary

- Brazilian Nuclear Policy
- Brief Presentation of the Brazilian Nuclear Programme
- The Safety of Spent Fuel Management and the Safety of Radioactive Waste Management
    1. CNEN's Safety Regulations
    2. SF and Radioactive Waste from NPPs
    3. Disused sources and other waste
    4. Other producer installations
- Brazil Matrix – an overview
- Current Challenges

BRAZILIAN NUCLEAR POLICY

- NUCLEAR ENERGY SHOULD BE USED ONLY FOR PEACEFUL PURPOSES (Constitutional Articles n.21 and 177)
- NUCLEAR MATERIAL PRODUCTION IS MONOPOLY OF THE FEDERAL GOVERNMENT – operation of NPPs and other nuclear facilities as research, mining, enrichment and reprocessing, industrialization and trade in nuclear ores.
  - *Principles of our Federal Constitution*
- SPENT NUCLEAR FUEL IS NOT CONSIDERED AS RADIOACTIVE WASTE
- FINAL DISPOSAL OF RADIACTIVE WASTE IS RESPONSIBILITY OF THE GOVERNMENT
  - *Stablished by Law*

Brief Presentation of the Nuclear Programme

- **NPPs**
  - ANGRA-1 – 610 MWe net – PWR – USA Technology
  - ANGRA-2 – 1,275 MWe net – PWR – German Tech.
  - ANGRA-3 – 1,330 MWe net – PWR – German Tech. – **UNDER CONSTRUCTION**
- **Nuclear Fuel Factory**
  - Unit I – Reconvertion and Pellets Fabrication
  - Unit II – Components and Assembly
  - Unit III – Enrichment
- **Uranium Mining and Milling –** Uranium Concentrate Unit (URA) at Bahia State
- Heavy Components Fabrication Facility

Brief Presentation of the Nuclear Programme

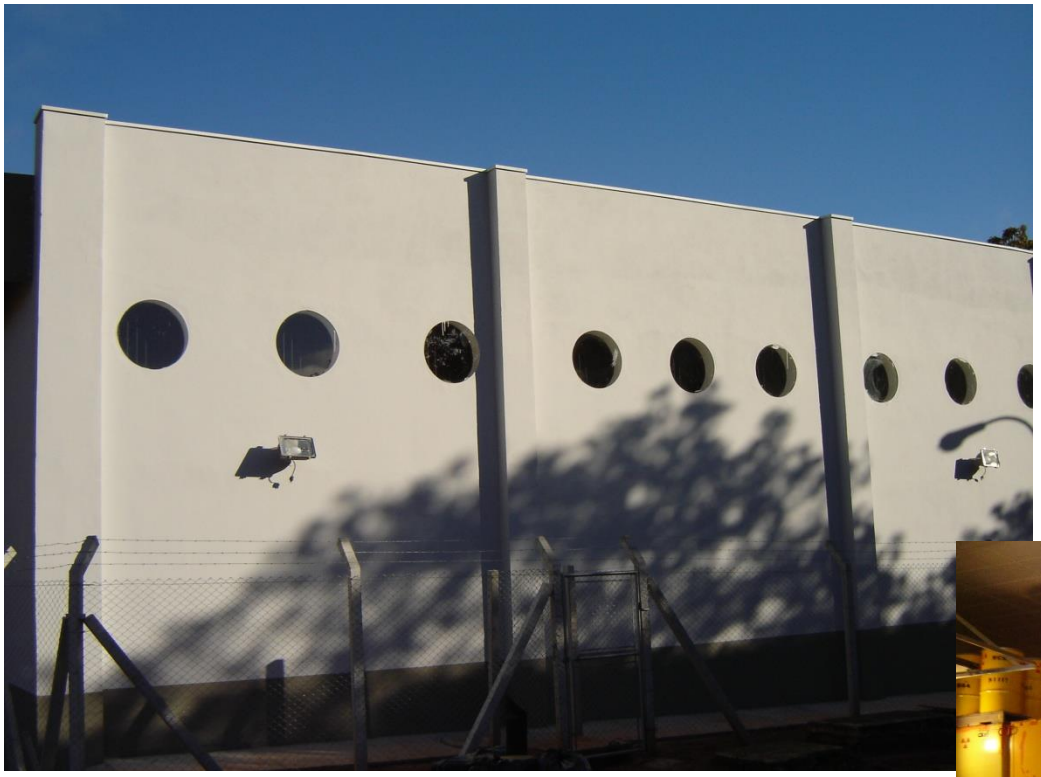
- CNEN Institutes
  - IPEN – SP
  - CDTN – MG
  - IEN – RJ
  - IRD – RJ
  - CRCN–NE
  - CRCN–CO – Abadia de Goiás Repository at State of Goiânia
- Research reactors
  - IEA–R1 (1957 - IPEN)
  - IPR–R1 TRIGA (1960 - CDTN)
  - ARGONAUTA (1965 - IEN)
  - MB–01 (1988 - IPEN)
  - **Multipurpose RR** – under licensing process
- Monazite sand processing (USAM, USIN, BOTUXIM)
- Exhausted uranium mine (UTM) – At Poços de Caldas City (MG)
- Navy Program (CTMSP and ARAMAR)
- Radioactive installations – (i.e., medicine, industry, research and education, distribution, services and cyclotrons)

Nuclear Power Plants

Nuclear Power Plants

Uranium Mining - Caetité, Bahia

Waste Storage Facilities at CNEN Institutes



IPEN
(SP)

Waste Storage Facilities at CNEN Institutes

CDTN
(MG)

Final Disposal Facility – Abadia de Goiás Repository

Great Capacity Container
(waste from group I)

Repository at Abadia de Goiás
(waste from group II to V)

The Safety of Spent Fuel Management and the Safety of Radioactive Waste Management

1- Safety Regulations of CNEN

2- SF and RAW from NPPs - main waste generator

3- Disused sources and other waste

4- Other producer installations

CNEN's Safety Regulations related to RAW

- ✓ CNEN-NN-3.01 – Radiation Protection Directives, January 2005.
- ✓ CNEN-NN-8.01 – Radioactive Waste Management for Low- and Intermediate-Level Waste – April 2014
- ✓ CNEN-NN-8.02 – Licensing of storage and disposal facilities for low- and intermediate-level radioactive waste – April 2014
- ✓ CNEN-NN 6.09 – Acceptance criteria for disposal of low and intermediate level radioactive wastes – Setember 2002 **(Currently under revision)**
- ✓ CNEN-NE 6.06 – Site Selection for radioactive waste storage and disposal facilities – December 1989.
- ✓ CNEN-NN-9.01- Decommissioning of Nuclear Power Plants – November 2012
- ✓ CNEN-NN-9.02 – Financial Management for Decommissioning of Nuclear Power Plants – October 2016
- ✓ CNEN-NN-1.10 – Safety of Waste Dam Systems Containing Radionuclides- November 1980 **(Currently under revision)**
- ✓ CNEN-NN-7.01- Certification of the Qualification of Radiation Protection Supervisors -May 2016.

2- SF and Radioactive Waste from NPPs

The spent fuel are stored in pools at the plant

Spent fuel is not considered radioactive waste in Brazil

Strategy for management of SF

No decision has been taken on reprocessing or disposal of spent fuel in Brazil, therefore **the current policy is to keep it in safe storage** until a technical, economic and political decision is reached about reprocessing and recycling the fuel, or disposing of it as such.

Inventory of spent fuel stored in the plant

Spent Fuel Assemblies Stored at Angra site

Storage place	Angra-1	
	Capacity	Occupied
New Fuel Storage Room	45	9
Region 1 Spent Fuel Pool	252	178
Region 2 Spent Fuel Pool	1,000	791
Total	1,297	978 (~75.4%)

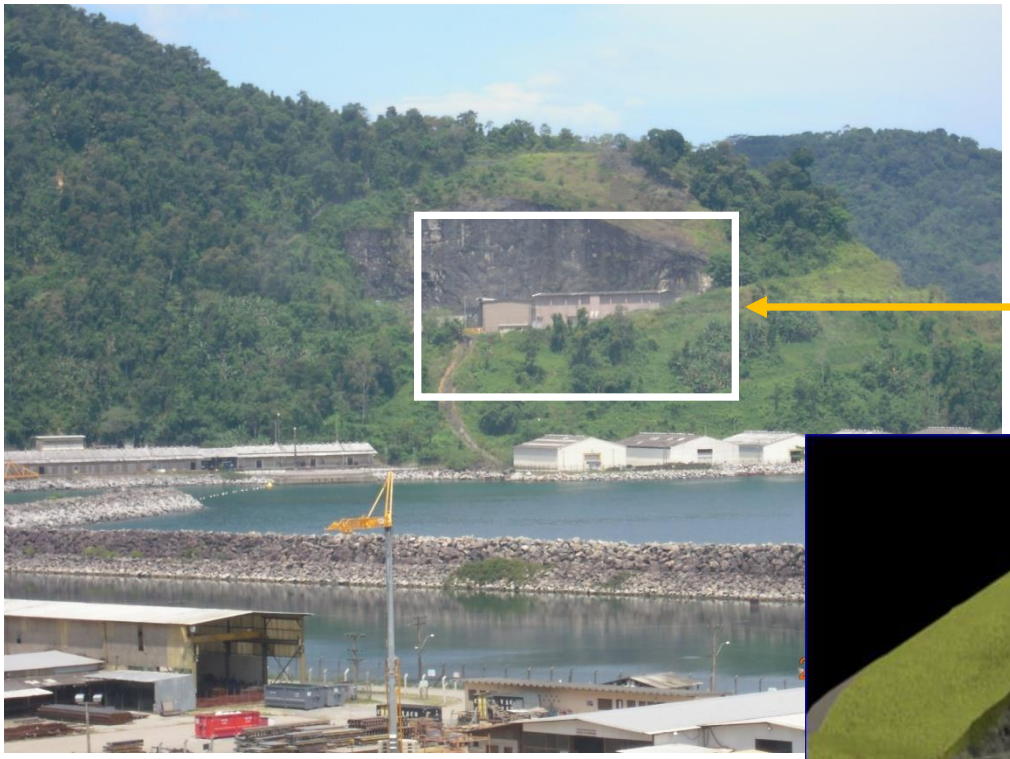
Storage place	Angra-2	
	Capacity	Occupied
New Fuel Storage Room	75	0
Region 1 Spent Fuel Pool	264	34
Region 2 Spent Fuel Pool	820	670
Total	1,159	704 (~61%)

Spent fuel stored in the plant

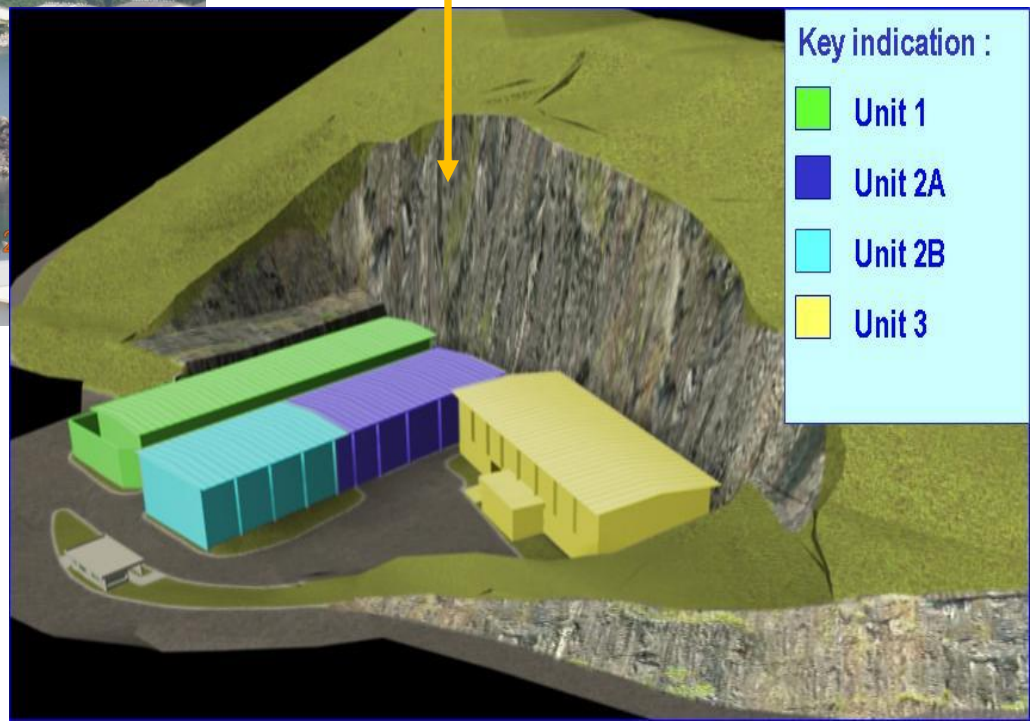
- Both units are provided with facilities that enable safe handling, storage and use of nuclear fuel. The design of the fuel pools and associated cooling systems and fuel handling systems assure adequate safety under authorized operation and under postulated accident conditions.

- For Angra-1 and 2, and in the future for Angra-3, a complementary dry storage unit is being implemented in order to complement the current on-site storage capacity of the plants. This installation is under Eletronuclear responsibility. The design bases of this solution is a Canister basis Dry Storage System, widely used by American Nuclear Power Station in USA.

LILW are in Storage Facilities at Angra site



Location and Schematic



On-site Waste Storage Facilities – at Angra site

On-site Waste Storage Facilities – at Angra site

New facility was constructed on site

Old Steam Generator Storage Building

Strategy for management of the LILW

- **The policy is to keep the waste safely isolated from the environment while a permanent solution is granted on national level.**

- In this sense, on November 2008, a Project named Low and Intermediate Level Waste Repository, the “RBMN Project”, was launched aiming at having a licensed and commissioned repository to dispose of the low- and intermediate-level waste.

- The site selection process aiming at the construction of the Brazilian Repository is on course.

Inventory of waste stored at Angra site

Waste Stored at Angra Site - Angra-1

Waste	Packages	Location
Concentrate	3,050	Storage Facility 1/ Storage Facility 2/ Storage Facility 3
Primary Resins	796	Storage Facility 2/ Storage Facility 3
Filters	534	Storage Facility 1/ Storage Facility 2/ Storage Facility 3
*Non-compressible	1004	Storage Facility 1/ Storage Facility 2/ Storage Facility 3/ SG Storage Facility
**Compressible	945 (817 drums + 128 B25 boxes)	Storage Facility 1 / Storage Facility 2 / Storage Facility 3
Secondary Resins	828	Storage Facility 1
TOTAL	7,157	*(Includes 206 Inactive drums)*

* Two Steam Generators and one reactor vessel cover are stored at SG Storage Facility.

** In 2006, the NPP supercompacted 1938 waste drums from Angra-1.The pellets (crashed drums) were placed inside special metallic boxes (B-25) with 2500 liters of capacity.

Inventory of waste stored at Angra site

Waste Stored at Angra Site - Angra-2

Waste	Quantity (drums)	Location
Concentrate	274	In Plant Storage
Primary Resins	140	In Plant Storage
Filters	16	In Plant Storage
Non-compressible	14	Storage Facility 3 and SG Storage Facility
*Compressible	379	In Plant Storage
TOTAL	**823**	-

* In 2006, the NPP supercompacted 89 waste drums from Angra-2.The pellets (crashed drums) were placed inside special metallic boxes (B-25) with 2500 liters of capacity.

3- Disused sealed sources and other RAW

Disused Sealed Sources in Storage

DRSS stored at CNEN's Institutes - June 2017

Institute	Number of Sources	Total Volume (m^3)	Total Activity (Bq)	Occupation Rate (%)
IPEN (SP)	152,530*	100,4	1.28E+14	~25
CDTN (MG)	11,864**	52	6.34E+13	~22
IEN (RJ)	20,085	190	3.24E+14	~51
CRCN-NE (PE)	1,068	32	1.76E+14	~21
TOTAL	**185,547**	**374.4**	**6.91E+14**	-

* This includes 137,748 ^{241}Am and ^{226}Ra sources from lightning rods and smoke detectors
**This includes 3,142 and 6,763 sources from lightning rods and smoke detectors, respectively, and also 90 200L-drums with treated wastes

- So far, the policy was to enforce the return of the disused sources to the manufacturer (*repatriation*), **once it is not possible**, these sources should be transferred to one of the CNEN's storage facilities. However, there is already a consensus among CNEN experts on the need to build boreholes (BOSS) as definitive solution for final disposal of DSS.

4- Other Producer Installations

Other Waste Generators

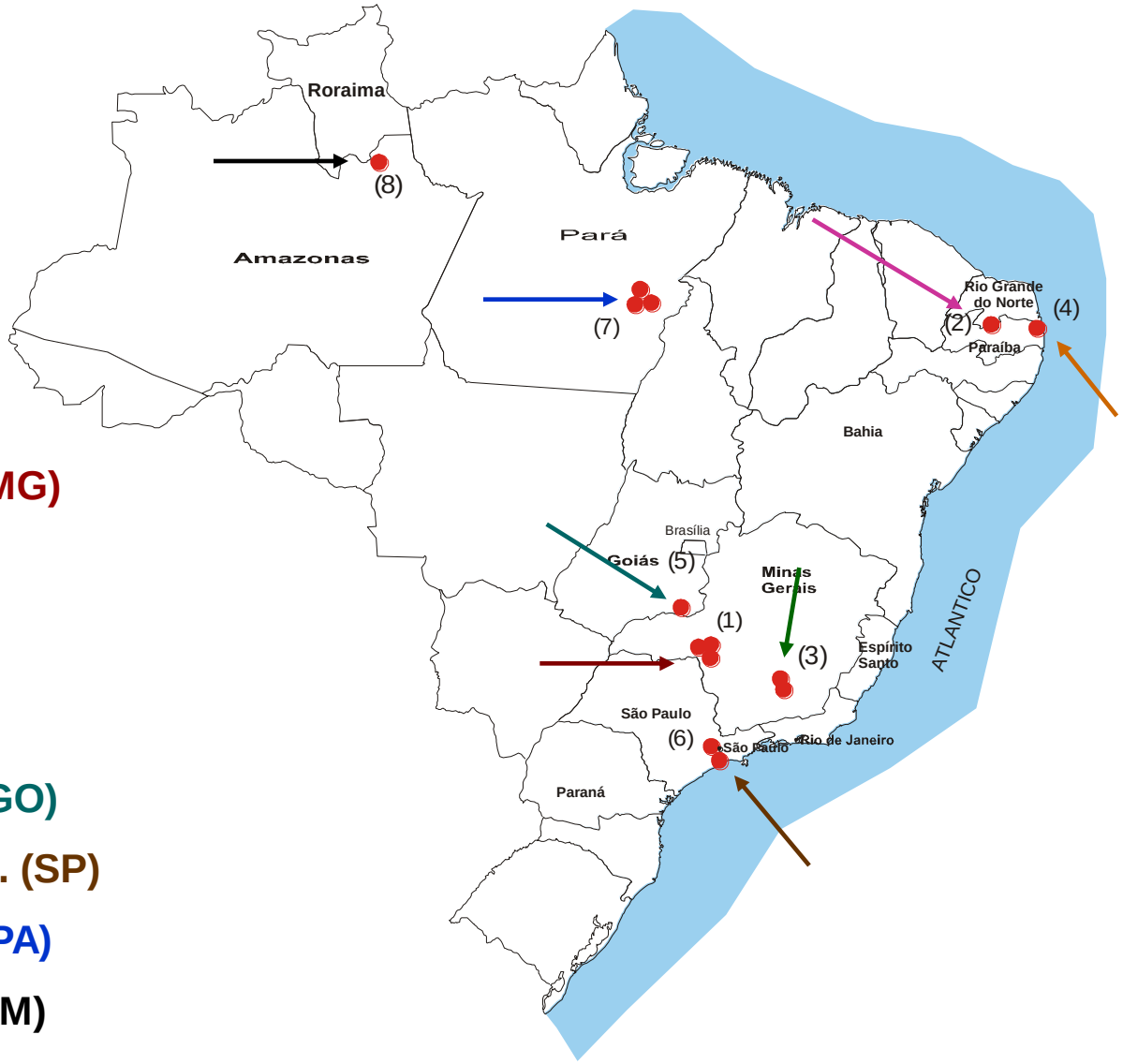
- One Industrial Facility for Processing the Monazite Sands (ES)
- Many Petroleum exploitation plants in many states – NORM

Contaminated Pipes and Equipments

Other Waste Generators

- One Industrial Facility for Processing the Monazite Sands (ES)
- Many Petroleum exploitation plants in many states – NORM
- Many mining and milling facilities with U and Th associated (niobium, tantalum, zircon etc – around whole country) – NORM – Naturally Occurring Radioactive Material

Mining and Milling Facilities in Brazil - NORM



1) Phosphate/Pyrochlore (MG)

2) Ta/Nb - Borborema (RN)

3) Sn, Ta/Nb - S.J.Rey (MG)

4) Ti, Zr - Mataraca (PB)

5) Phosphate/Pyrochlore (GO)

6) Sn, Nb/Ta - Pirapora B. J. (SP)

7) Cu - Serra do Sossego (PA)

8) Sn, Nb/Ta, Zr - Pitinga (AM)

BRAZIL MATRIX

Type of Liability	Long Term Management Policy	Funding of Liabilities	Current Practice / Facilities	Planned Facilities
Spent Fuel	Long term storage or reprocessing - Waiting for an economic and political decision	OPERATOR (ETN)	STORAGE ON SITE (POOLS) complementary dry storage unit is foreseen	ADDITIONAL ON-SITE WET STORAGE Long term cask storage (under examination)
Nuclear Fuel Cycle Wastes	Not defined yet	OPERATOR (INB)	STORAGE ON SITE	None
Application Wastes	LILW Repository (RBMN Projec)	LICENSEES + CNEN	STORAGE AT CNEN INSTITUTES	LILW Repository (RBMN Projec)
Decommissioning Liabilities	Not defined yet	OPERATOR (ETN)	None	Not defined yet
Disused Sealed Sources	Storage at CNEN Institutes while awaiting a final decision on borehole disposal (BOSS)	LICENSEES + CNEN	RETURN TO MANUFACTURER OR STORAGE AT CNEN INSTITUTES	Not defined yet

CURRENT CHALLENGES

- Design, licensing and construction of the LILW Repository – RBMN Project – site selection to be concluded

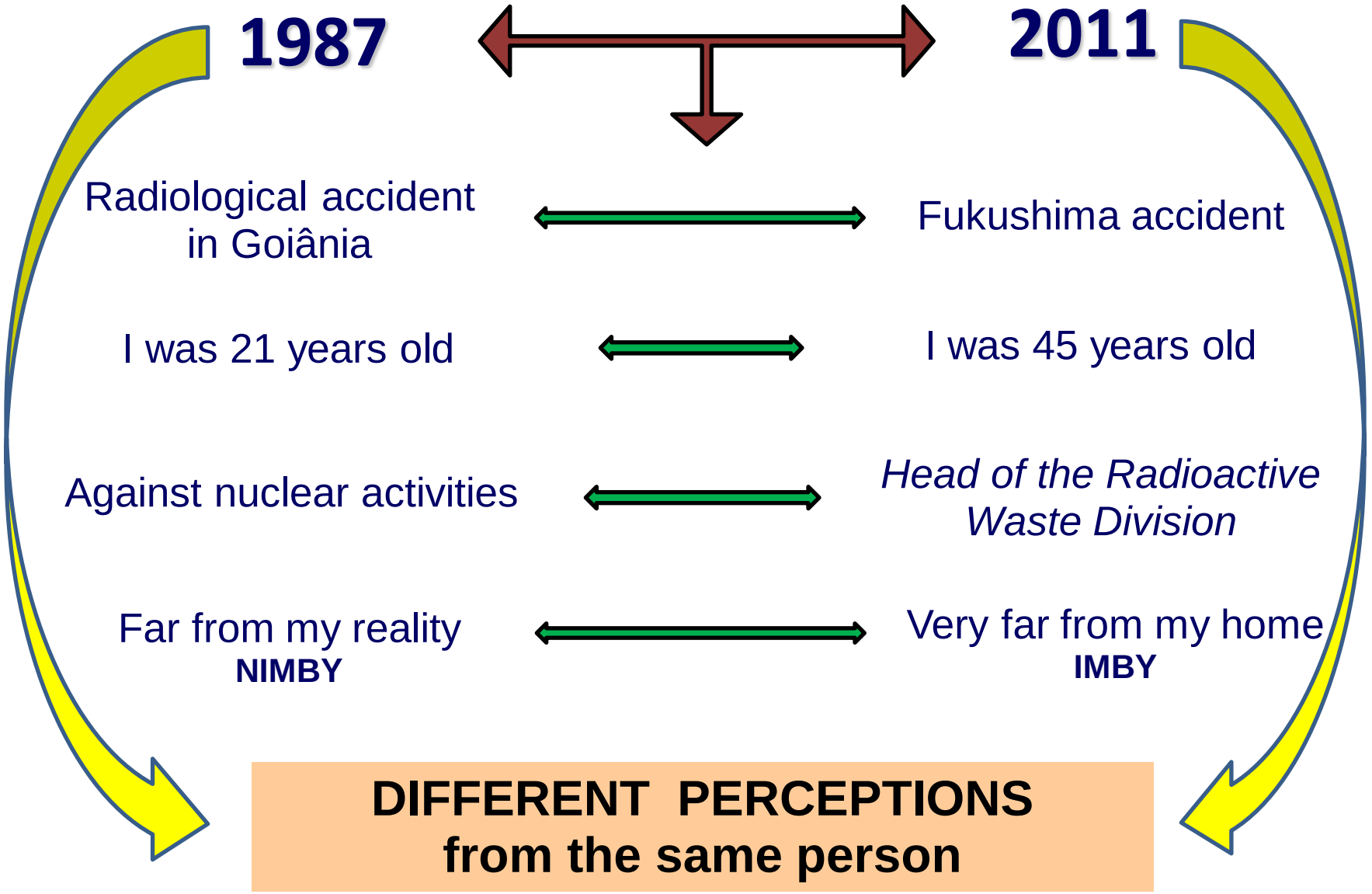
- Licensing and construction of the Multipurpose Brazilian Reactor (RMB Project) – currently under licensing process

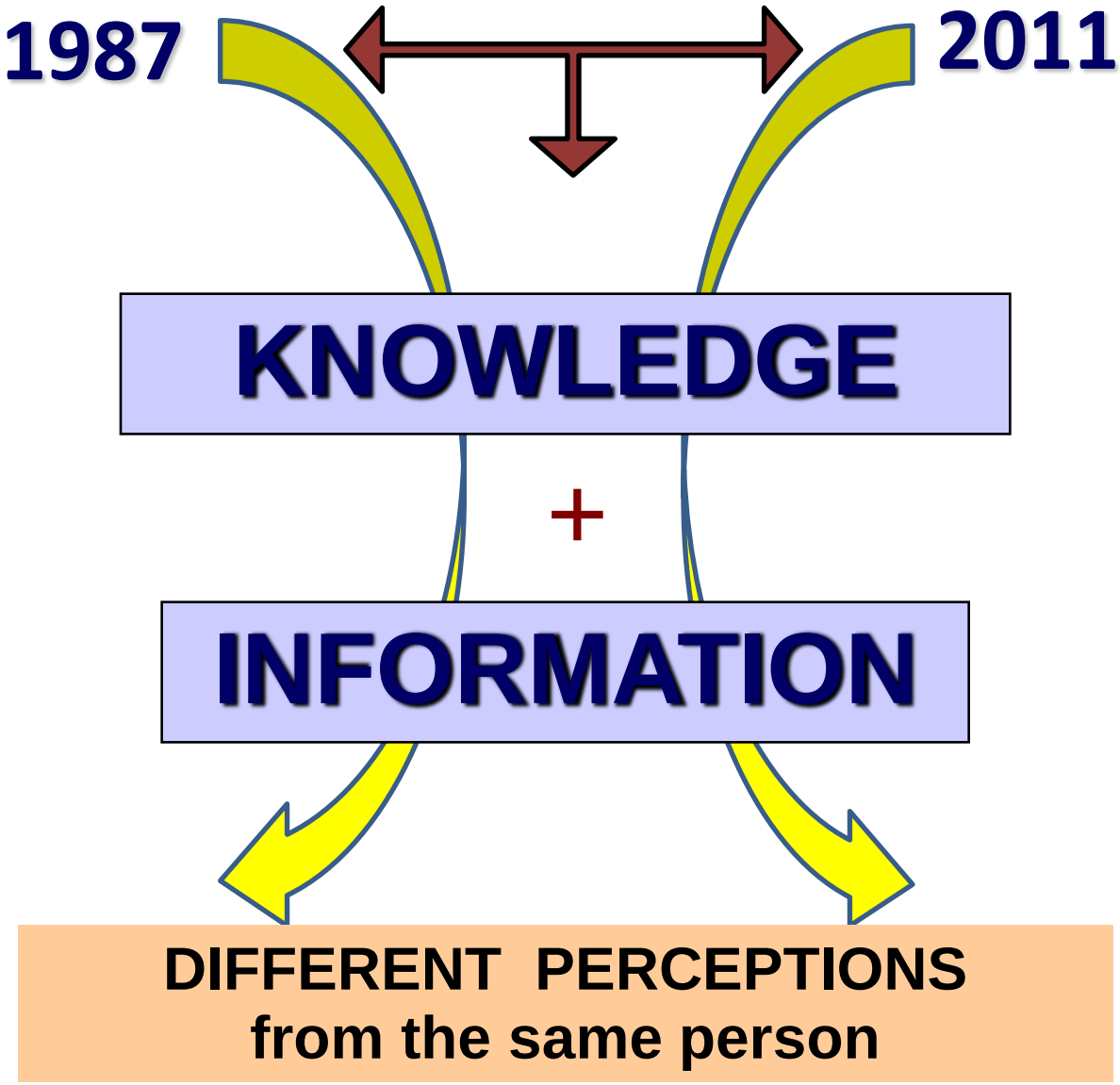
- Finalize the construction of Angra-3, the date for the start of commercial operation of the Plant is now scheduled for January 2024.

- Develop a strategy for long term management of SF – a complementary dry storage unit is being implemented in order to improve the current on-site storage capacity, and also a long term dry storage is being considered.

Public Acceptance

just a personal view


1987
2011
Radiological accident in Goiânia
Fukushima accident
I was 21 years old
I was 45 years old
Against nuclear activities
Head of the Radioactive Waste Division
Far from my reality
NIMBY
Very far from my home
IMBY
DIFFERENT PERCEPTIONS
from the same person


1987
2011
KNOWLEDGE
+
INFORMATION
DIFFERENT PERCEPTIONS
from the same person

Thanks for your attention!

maleal@cnen.gov.br

Decommissioning

CNEN has issued on October 2016 a new regulation NN-9.02 - Financial Management for Decommissioning of Nuclear Power Plants [30], that established the basic requirements for the management of financial resources, complementary to those established in article 15 of the CNEN-NN-9.01 (Decommissioning of Nuclear Power Plants - November 2012), including the management of radioactive waste generated during decommissioning

The provision of funds for decommissioning activities is obtained from ratepayers, and is included in the tariff structure, during the same period of depreciation of the plant (3.3%/year). For Angra-1, presently, a reference decommissioning cost of 431 million dollars is estimated. For Angra-2 the decommissioning costs are estimated in about 529 million dollars, in Dec 2013.

A preliminary decommissioning plan (PDP) was made by Eletrobras Eletronuclear (ETN) and sent to CNEN on November 2014.

Regulation NN-9.01

Art. 10 – The decommissioning strategy selected by the operating organization must meet the following requirements:

- I – consider the international experience, as well as the current national polices for the decommissioning and waste management, and;
- II – provide ways to and storage wastes of all classes to be generated during the decommissioning activities.