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Uranium Legacy Sites in Brazil

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Licensing of Nuclear Fuel Cycle Facilities

Brazilian Nuclear Energy Commission - (CNEN)

Licensing Process (Brazil)

Nuclear Installation - Nuclear Fuel Cycle Installations (including **Mine and Processing of Uranium**)

Nuclear installations are subject to both:

1 - A **Nuclear License**, by CNEN (created in **1956**); and

(Ministry of **Science, Technology and Innovation**)



CNEN

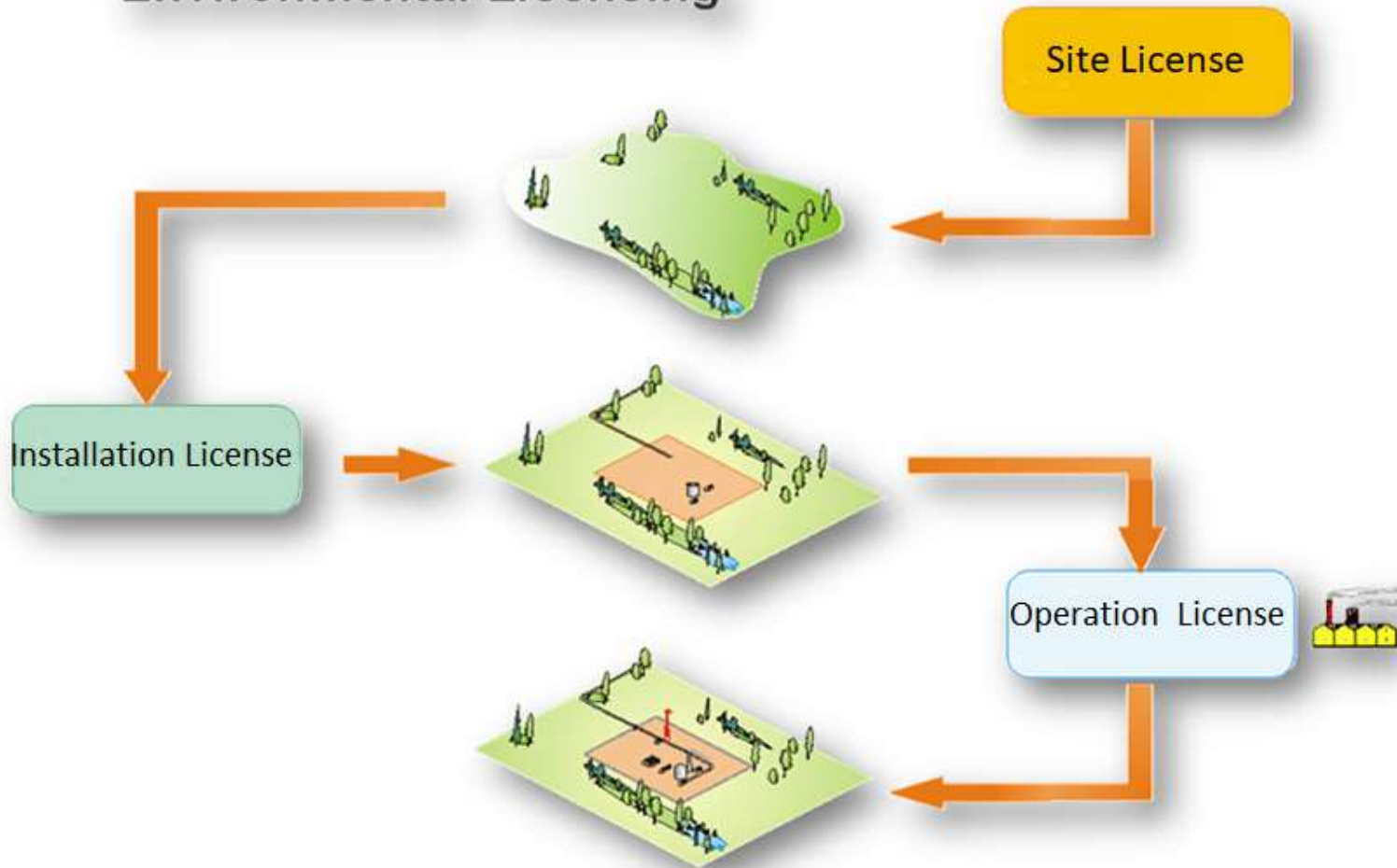
2 – An **Environmental License**, by the Brazilian Institute for the Environment and Renewable Natural Resources – IBAMA (**created in 1989**), with the participation of state and local environmental agencies.

(Ministry of **Environment**)



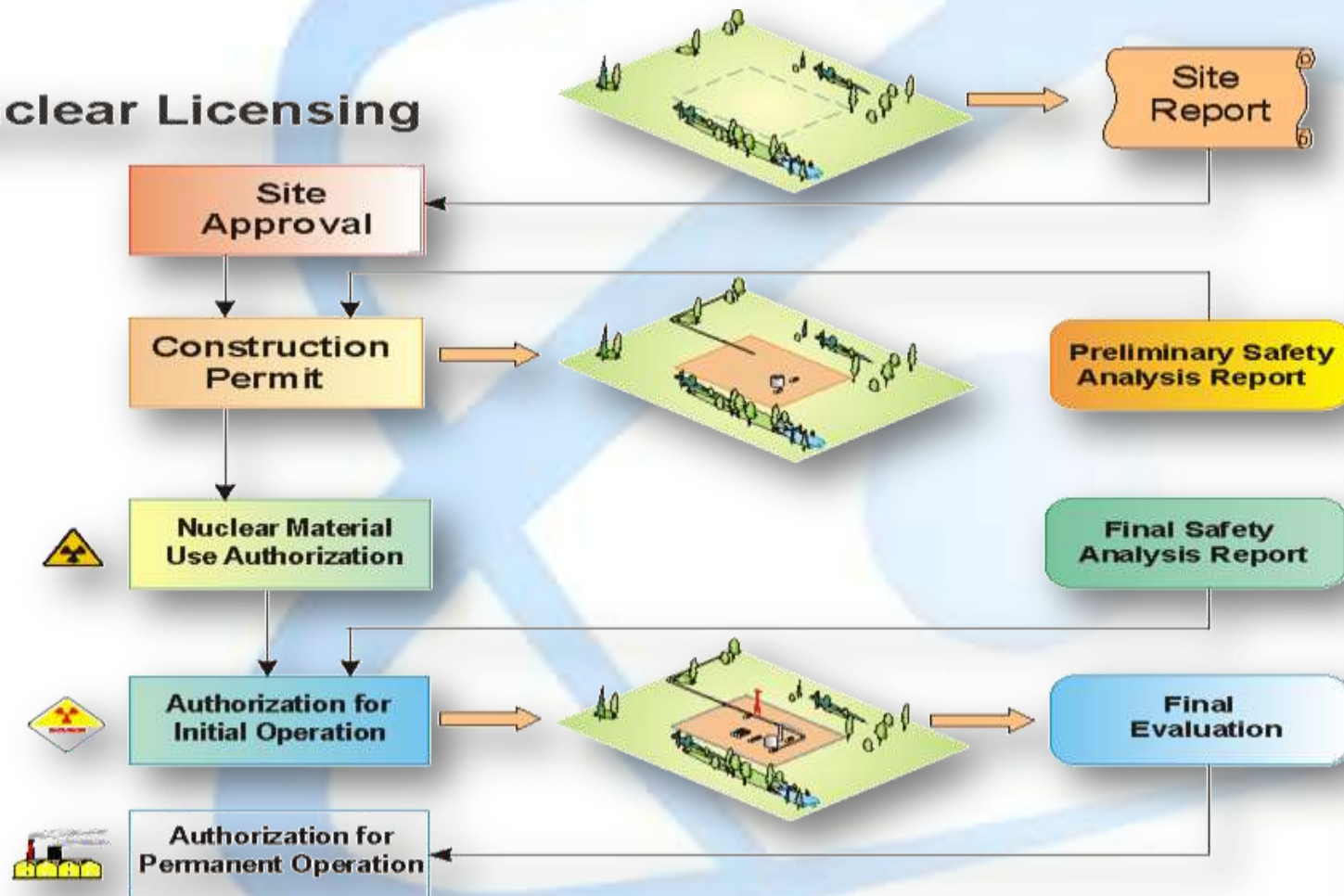
Brazilian Environmental Licensing Process: IBAMA (created 1989)

Environmental Licensing



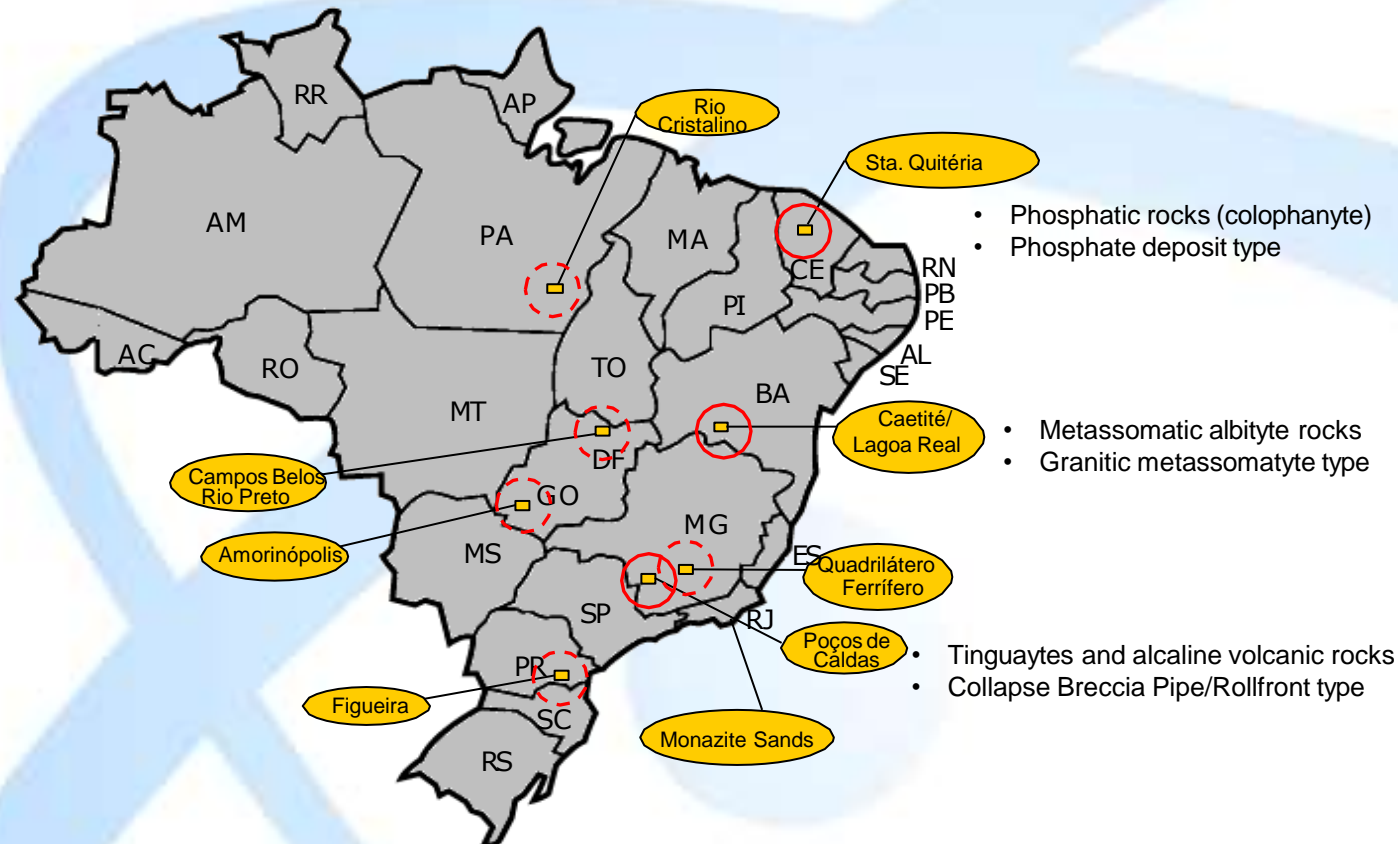
Brazilian Nuclear Licensing Process: CNEN (created 1956)

Nuclear Licensing



LOCATION OF URANIUM DEPOSITS AND URANIUM RESOURCES^A

8



ORE/DEPOSIT	RESOURCE CATEGORY				TOTAL
	REASONABLY ASSURED RESOURCES (RAR)			ESTIMATED ADDITIONAL RESOURCES (EAR)	
	U ₃ O ₈ <20 US\$/lb	U ₃ O ₈ <40 US\$/lb	TOTAL	U ₃ O ₈ <40 US\$/lb	
Poços de Caldas	-	500	500	4.000	4.500
Caetité/Lagoa Real	24.200	69.800	94.000	6.770	100.770
Sta. Quitéria	42.000	41.000	83.000	59.500	142.500
Others ^b	-	-	-	61.600	61.600
TOTAL	66.200	111.300	177.500	131.870	309.370

^a Metric tons of U₃O₈

^b Reserves related to deactivated projects such as: Rio Cristalino (PA); Amorinópolis and Rio Preto/Campo Belo (GO); Poços de Caldas and Gandarela (MG); Figueira (PR) and Espinharas (PB)

Uranium Legacy Site in Brazil

Poços de Caldas Mine

The first uranium mining and processing facility of Brazil - CIPC - located at the Poços de Caldas plateau, in the state of Minas Gerais

- U was produced to supply the domestic demand (2 PWR-type reactors);
- The installation was operated by state-owned company – The Brazilian Nuclear Industries (INB);
- Uranium was mined by open pit and the extraction process was sulfuric acid leaching.
- The site was licensed according the Nuclear Regulations (70's) - Licensed as a Nuclear Installation (Constitution)



Poços de Caldas Mining and Processing Facilities



September, 1948 - Radioactivity detected in the site;

October, 1952 - Beginning of the Uranium Research;

1st semester, 1977 - End of the Uranium Research;

May, 1982 - Beginning of operations;

December, 1995 - End of production.

Total Production - **1.200 t** de U_3O_8

“Low” Grade Uranium Deposit : **675 - 1705** ppm of uranium

Licensing Process

POÇOS DE CALDAS MINING AND PROCESSING FACILITIES

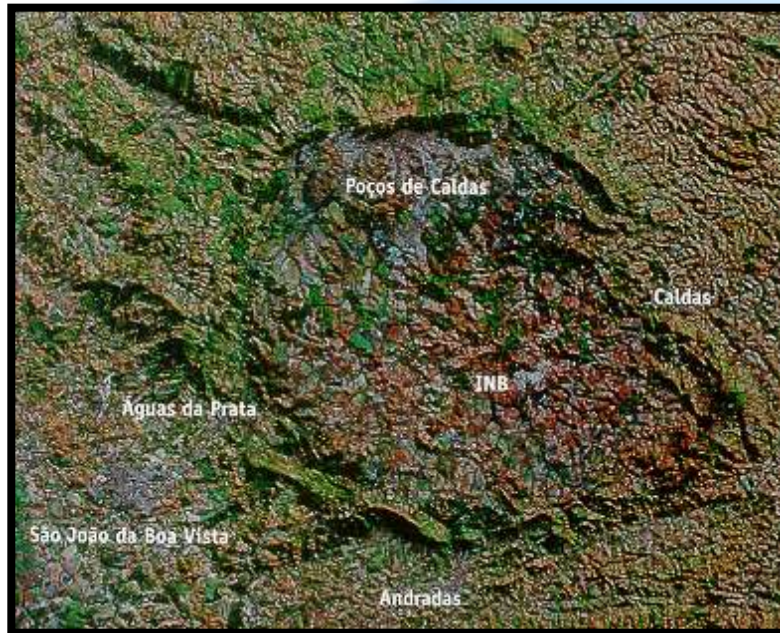
- ✓ When the nuclear licensing process took place in the late 70's - early 80's, no planning was made for the decommissioning phase;
- ✓ Mining and Processing were developed before the establishment of the environmental legislation (1989);
- ✓ At that time, the Operator did not have the legal obligation of presenting an Environmental Impact Statement (EIS) prior the operation of the mining and processing facilities.

→ **Legacy**

POÇOS DE CALDAS MINING AND PROCESSING FACILITY

- ✓ Therefore, the installation began operating with a nuclear license issued by CNEN without complying with a specific environmental licensing process. This is presently a mandatory step in Brazil (IBAMA did not exist at that time);
- ✓ To address this situation a Term of Environmental Commitment (TEC) was signed by the mining company, IBAMA and CNEN;
- ✓ TEC established that the operator must submit an [Impacted Areas Recovery Plan](#).

Poços de Caldas Mining and Processing Facilities



Main Characteristics:

- ➔ Located close to important tourist cities between 2 major drainage basins (Antas & Verde rivers);
- ➔ The water is used for irrigation and cattle watering.

Impacted Areas Recovery Plan

- Main sources of contamination:
 - Tailings Management Facility (*TMF*);
 - Waste Rock Piles (*WRP*);
 - Open Pit Mining Area;
 - Industrial ore processing and storage facilities.

- Chemical plant treatment of the liquid effluent is still in operation.



Impacted Areas Recovery Plan



- ✓ Site characterization and baseline data;
- ✓ Four individual areas (AREA 1 -Tailings Dam; Area 2 - Waste Rock Piles nº 4 and 8; Area 3 – Open Pit; Area 4 – Industrial Area) assessed in an integral way;
- ✓ Waste characterization;
- ✓ Water & Load balance;
- ✓ Remediation goals and evaluation criteria;
- ✓ Description and assessment of remediation strategy / technical measures;
- ✓ Cost estimation;
- ✓ Time Schedule.

Total Area of the site: 32 km²

AREA 2
Waste Rock Pile 4

AREA 3
Open Pit Mining Area

AREA 2
Waste Rock Pile 8

AREA 1
Tailing Dam

AREA 4
Industrial Area



Some Issues

- The mining site → high precipitation rates;
- Considering the generation of Acid Drainage and the high precipitation rates, great volumes of water need to be treated to avoid undue releases of radionuclides and heavy metals into the environment;
- As a result of the water treatment, large amounts of sludge containing significant levels of radionuclides and heavy metals need to be disposed off;
- Radiological control of the site is maintained by the Operator, especially at effluent discharge points, in particular from the waste dam and the drainage water treatment units from the mining area and waste rock piles.
- The lessons learned from the site closure will impact significantly the operation and closure of future uranium sites in Brazil.
- Decision needed concerning the dismantling of the industrial area and site remediation.
- Relevant information about the site is dispersed.



Uranium Legacy Site in Brazil

Monazite Processing Industry - 3 Legacy sites



The southeast coastal region of Brazil has rich deposits of heavy minerals, the major constituents being zircon, rutile and monazite;

The monazite content of the beach sands generally varies from <0.1 % to 2 %.

Monazite of Brazil origin contains Th as ThO_2 U as U_3O_8 and Rare Earths elements.

Mining, milling and chemical processing (extraction of the rare earth elements) resulting in occupational and environmental radiation exposures.

Chemical processing
2 installations – São Paulo

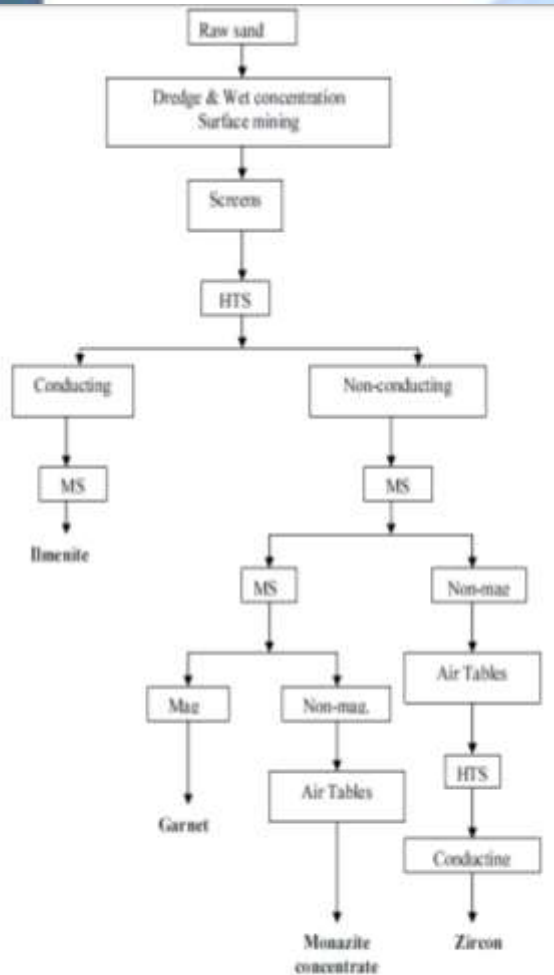
Mining and Mineral Separation
1 installation (Rio de Janeiro)

Monazite Processing Industry

Mining, mineral separation and concentration of rare earth ores

1 Installation in Rio de Janeiro State

- ✓ Surface mining, collection of beach washings and dredge mining are the mining methods adopted;
- ✓ The mineral separation plants (MSPs) make use of the differences in the electrical and magnetic properties and differences in specific gravity of the constituent minerals to separate them;
- ✓ The dredged sand is concentrated by slurring in water and passing down through spirals;
- ✓ The dried concentrate is passed through a series of high tension electric separators and magnetic separators of varying intensities;
- ✓ Wet tabling and froth floatation effect fine separation of some minerals;
- ✓ During final stages of monazite separation, air tabling also is adopted.



HTS - High Tension Separator
MS - Magnetic Separator

Fig. 1. Simplified process flow sheet for monazite separation

Monazite Processing Industry

Mining, mineral separation and concentration of rare earth ores



Monazite Processing Industry

Mining, mineral separation and concentration of rare earth ores



→ Long-term storage - the sand/monazite bearing wastes are segregated, appropriately transported and stored in trenches;

→ Trenches are periodically topped with mineral free sand to keep the radiation fields up to limit of the natural levels encountered in the area;

→ The mined and refilled areas are replanted and rehabilitated;

→ There is a continuous reforestation programme for restoring the ecological balance to the maximum extent possible.



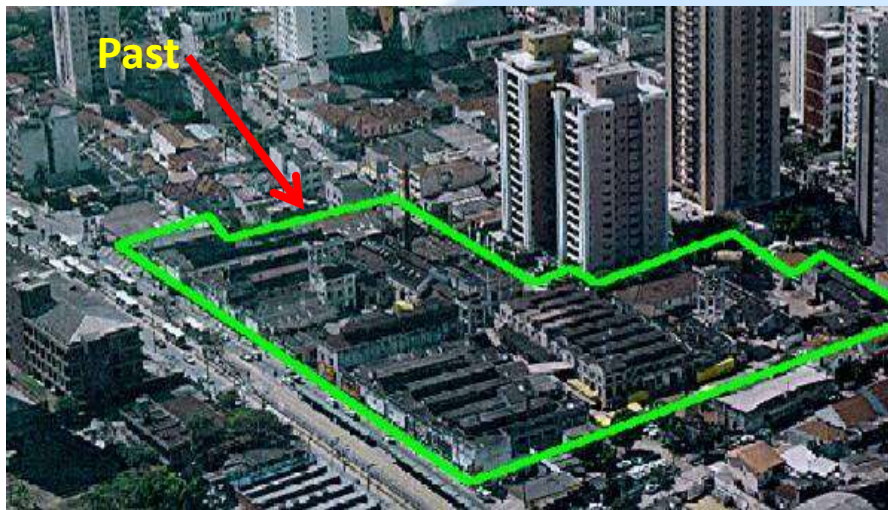
CHEMICAL PROCESSING OF MONAZITE (2 Installations) - SÃO PAULO CITY
Brazil's Largest City - Population 19,000,000 inhabitants



Monazite Chemical processing Installation – Remediated (1998)

1st Unit - Began operating in the mid-1940s

By-product : Uranium and Thorium concentrate



Today



Monazite Chemical Processing Installation– 2nd UNIT Site under remediation



Site Characteristics

✓ Total Area: 60.000 m²;

✓ Used to:

- Store material resulting from the research and development of Uranium and Thorium ore processing;
- Store uranium and thorium concentrate;
- Store heavy fractions of the monazite sand processing plant;
- Dispose of silica residues from the monazite sand processing;
- Store wastes from the decommissioning of USAM (monazite sand chemical processing plant);

Contaminated Soil Monitoring and Removal



30 Cm



60 Cm



90 Cm

CHARACTERIZATION



- Characterization Surveys according release criteria;
- Remedial Action Support Surveys;
- Final Report.

Today → The site was partially released for unrestricted use (accesses to two main roads).

MAIN RESULTS

- ✓ The largest volume of contaminants was identified as being heavy mineral sands (monazite mainly);
- ✓ The soil containing heavy minerals is being processed in the heavy mineral processing plant;
- ✓ The amount of radioactive waste generated was reduced to 5,2 tons and it is temporarily stored on site;
- ✓ The radiological control of workers resulted in values below 0,2mSv/y.

FINAL REMARKS

Specific challenges and needs

- Legacy Sites -

- ✓ The evaluation and demonstration of safety of uranium sites (e.g, dose assessment, site characterization, land use restrictions);
- ✓ The establishment of specific regulation defining clearance levels and unconditional release;
- ✓ Political and psychosocial aspects (e.g, stakeholder involvement and communication);
- ✓ Financial provisions;
- ✓ Definition of a site for long term storage of the radioactive waste generated.

Legacy Sites challenges and needs

New technologies and safety standards have resulted in the need for:

- ✓ developing and updating safety regulations and guides, adopting high-tech measuring equipment and safety assessment software;
- ✓ the establishment of common grounds among Institutions responsible for the uranium sites in order to improve the human resources and to reduce legal competence gaps and overlaps.

Thank you for your attention!

