LAS-ANS Symposium

SITING OF NEW NUCLEAR POWER PLANTS AND IRRADIATED FUEL FACILITIES

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BRAZILIAN REGULATORY ACTIONS AFTER FUKUSHIMA DAIICHI

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Summary

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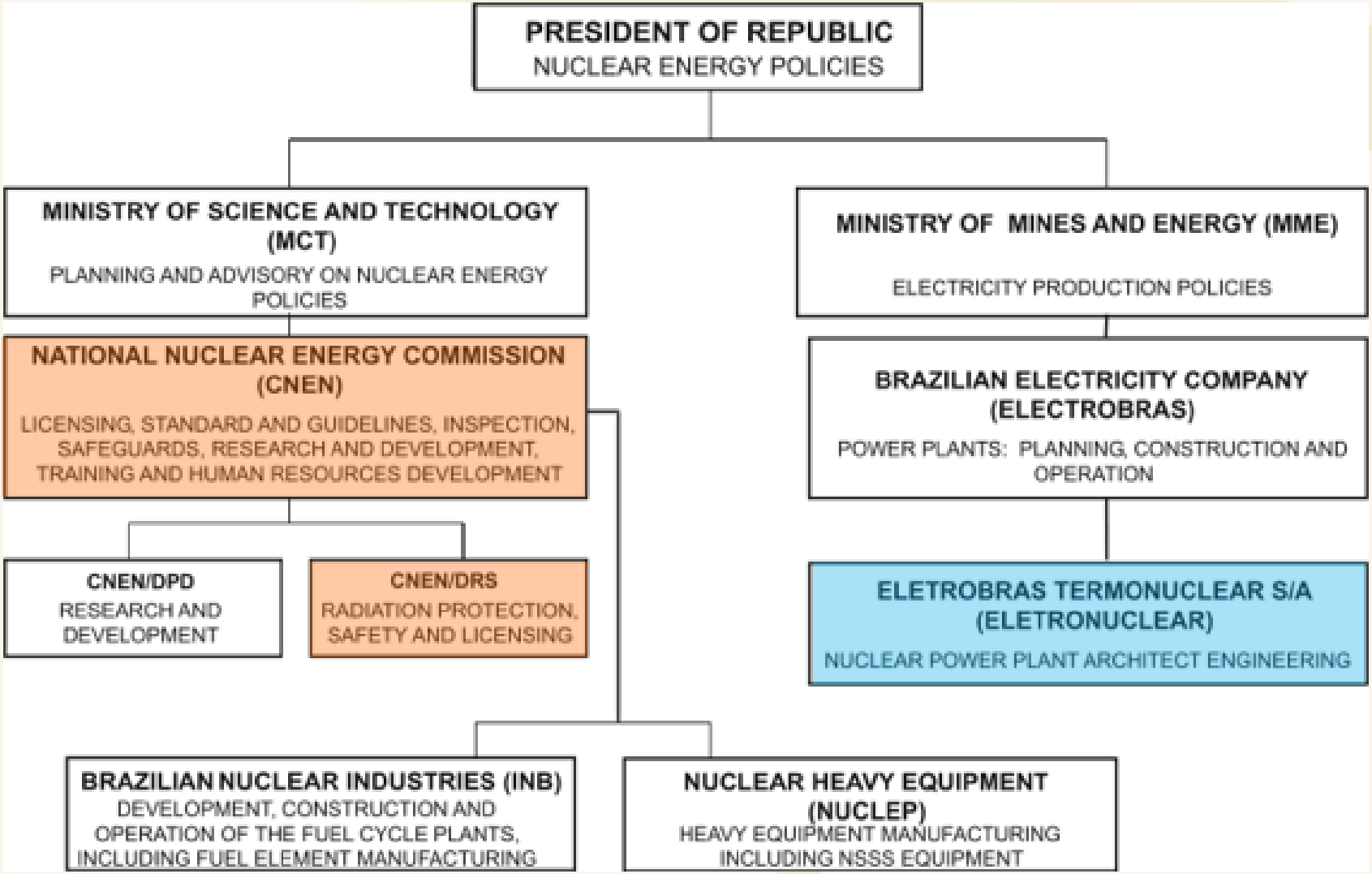
Brazilian Nuclear Sector Organization



ANGRA Nuclear Power Plant

- Administrated by ELETRONUCLEAR, a state company with the monopoly in nuclear power generation in Brazil
- Angra I, Westinghouse PWR, 637 MWe (1985)
- Angra 2, Siemens/KWU PWR, 1350 MWe (2000)
- Angra 3, Siemens/KWU PWR, 1405 MWe (2018)

Angra 2 / Angra 1

Angra 3

Regulatory requests from CNEN to ELETRONUCLEAR after Fukushima (1/2)

In may 2011, CNEN requested from ELETRONUCLEAR the following actions/evaluations:

- Identification of the main differences between Fukushima and Angra NPPs designs;
- Identification of possible initiating external (extreme) events and internal events that potentially could result in a common cause failure;
- Control of hydrogen concentrations in the containment;
- Guaranty of emergency electric energy supply;
- Compliance with station black-out requirements;

Regulatory requests from CNEN to ELETRONUCLEAR after Fukushima (2/2)

- Service water system, cooling network;
- Procedures for severe accidents;
- Access to reactor building and controlled area after a severe accident;
- Development of Probabilistic Safety Analysis Level 1, 1^{+} and 2;
- Stress test evaluations;
- Emergency plan.

Actions taken by ELETRONUCLEAR in response to CNEN requests (1/5)

- Creation of the **Response Plan to Fukushima** – a broad planning of studies and designs for safety reevaluation of Angra NPP in the light of the lessons learned from Fukushima Daiichi accident;

- **Stress test evaluations** based on the specifications published in the FORO report “Evaluación de Resistencia de las Centrales Nucleares en los Países Miembros del Foro Iberoamericano de Organismos Reguladores Radiológicos y Nucleares”;

- The final Stress Test Report was issued in march 2012;

Actions taken by ELETRONUCLEAR in response to CNEN requests (2/5)

- The **Response Plan to Fukushima**, which is under development since 2011, is organized into **three major evaluation areas**:
  - **Protection Against Risk Events**
  - **Cooling Capacity of Reactor and Pools**
  - **Control of Radiological Consequences**

- More than 50 initiatives comprised by studies and projects;

- The **priorities** of the Plan have been oriented by the results of the stress test evaluations and by those **initiatives that would bring the most significant gains in safety margins** in the short and medium term;

Actions taken by ELETRONUCLEAR in response to CNEN requests (3/5)

Main initiatives in the area of **Protection Against Risk Events**:

- Reevaluation of **seismic hazard**, with updated geological and seismological databases and an adequate probabilistic treatment.
- Reevaluation of the protection pier of Angra site taking into account **sea movements** determined by **severe meteorological conditions**;
- Reevaluation of scenarios considering **severe rains and landslides**;
- Evaluation of the impact of **tornadoes**;
- Reevaluation of **hurricane hazard**;

Actions taken by ELETRONUCLEAR in response to CNEN requests (4/5)

Main initiatives in the area of **Cooling Capacity of Reactor and Pools**:

- Evaluation of **bleed-and-feed procedures for beyond-the-design basis conditions**;
- Acquisition of **mobile equipment for emergency** electrical energy supply, batteries recharge, water supply for the steam generators and air supply for valve actuation;
- Improvement of **service water supply system** of the plant (new adduction lines; new water reservoir seismically qualified and at an elevation high enough to feed the steam generators in a completely passive way);
- Study of alternative ways for **pool cooling in station black-out scenarios**;

Actions taken by ELETRONUCLEAR in response to CNEN requests (5/5)

Main initiatives in the area of **Control of Radiological Consequences**:

- Implementation of **guidelines for Severe Accident Management**;
- Installation of **hydrogen catalytic recombiners**;
- Installation of **containment venting** systems;
- Study of alternatives for **emergency control points**;
- Study and implantation of **alternatives routs for people evacuation in emergency situations**.

Brazilian Standard - Site Approval for Nuclear Power Plants (1/2)

- CHAPTER I – SCOPE
- CHAPTER II – CRITERIA
  - Section I - Hazards Associated to External Natural and Anthropic Events
  - Section II - Potential Impacts of the NPP on the Region
  - Section III - Emergency Plan Considerations
- CHAPTER III - REQUIREMENTS FOR SITE EVALUATION
  - Section I - Geology and Seismology
  - Section II - Meteorology
  - Section III - Hydrology and Water Resources

Brazilian Standard - Site Approval for Nuclear Power Plants (2/2)

- CHAPTER IV - CHARACTERISTICS OF THE SITE AND POTENTIAL EFFECTS OF THE PLANT ON THE REGION
  - Section I - Atmospheric Dispersion of Radioactive Material
  - Section II - Dispersion of Radioactive Material in Surface Water
  - Section III - Dispersion of Radioactive Material in Groundwater
  - Section IV - Land and Water Use in the Region
  - Section V - Population Distribution
  - Section VI - Radiological Environmental Impact Assessment
- CHAPTER V - QUALITY ASSURANCE
- CHAPTER VI - FINAL PROVISIONS

Concluding Remarks (1/2)

- **Despite the big differences between Fukushima Daiichi and Angra (site and plant design), Fukushima tragic experience has led to a complete reevaluation of Angra NPP safety margins related to extreme events;**

- **Several studies are being conducted and safety improvements implemented in the units Angra 1 and Angra 2 (the Response Plan to Fukushima progress status is closed followed by CNEN through reports sent by ELETRONUCLEAR every three months);**

- **The lessons from Fukushima are also reflected in the design basis of Angra 3, which is under construction, mainly with respect to reevaluation of external hazards;**

Concluding Remarks (2/2)

- **Fukushima experience also influenced the new Brazilian standard "Site Approval for Nuclear Power Plants", specially with regard to:**
  - **impact evaluation of multi-unit plants;**
  - **comprehensive investigation of the site characteristics with regard to external hazards;**
  - **use of probabilistic methodologies whenever possible;**
  - **risk evaluation of combined events (for example, landslides during severe rains and earthquake);**
  - **extensive data collection for evaluation of the potential effects of the plant on the region adjacent to the site;**
  - **assurance of viability for implantation of an effective emergency plan.**

Thank You for Your Attention

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