SPENT FUEL MANAGEMENT AT CNAAA[1]– ELETRONUCLEAR[2] – BRASIL

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Abstract

This work aims to describe the strategies of management of spent fuel assemblies in the CNAAA power plants adopted as a function of the depletion of the storage capacity of their spent fuel pools. Having chosen the option of dry storage this has the intention to describe the main participants, the Brazilian nuclear policing, the spent fuel storages, the strategy adopted to manage the decrease in storage capacity, the implementation schedule and the current status.

1. INTRODUCTION

In 2000, studies were initiated to determine the strategy to be established for later storage of spent fuel assemblies, establishing a planning for the depletion of the storage capacity of the Angra 1 and Angra 2 pools and completion of the independent storage facility construction. The initial idea was to use storage in pools similar to those of the reactors, because they are projects already known by the company. These studies determined the site and established operational strategies to establish a schedule contemplating the dates of the pools' depletion in the reactors.

Subsequently, the initial idea was reviewed, opting for the dry storage in cans inside the place where the plants are located, using the same place previously chosen, as well as the timetables for their conclusion based on the time necessary to fill the reserves in operation.

Currently, the company is in the process of implementing dry storage of spent fuel, from which the first shipment should occur in 2021.

2. MAIN PARTICIPANTS OF THE IMPLEMENTATION PROCESS

CNEN - The National Nuclear Energy Commission (CNEN) is a federal agency linked to the Ministry of Science, Technology, Innovations and Communications (MCTIC), created in 1956 and structured by Law 4,118, of August 27, 1962, to develop the national policy of nuclear energy. The CNEN establishes norms and regulations in radioprotection and is responsible for regulating, licensing and supervising the production and use of nuclear energy in Brazil.

IBAMA - The Brazilian Institute for the Environment and Renewable Natural Resources, better known by the acronym IBAMA, created by Law 7,735 of February 22, 1989, is a federal authority linked to the Ministry of the Environment (MMA).

HOLTEC - Holtec International is a global turnkey supplier of equipment and systems for the energy industry based in Camden, New Jersey, United States. It specializes in the design and manufacture of parts for nuclear reactors. The company sells equipment to manage spent nuclear fuel from nuclear reactors. Holtec makes the casks used for storage of spent fuel.

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[1] CNAAA -The Admiral Álvaro Alberto Nuclear Power Center is formed by the Angra 1, Angra 2 and Angra 3 (under construction) nuclear power plants (NPP), owned by ELETRONUCLEAR

[2] ELETRONUCLEAR - Eletrobras Eletronuclear was created in 1997 with the purpose of operating and building thermonuclear power plants in Brazil. Subsidiary of Eletrobras, is a mixed-economy company and accounts for approximately 3% of the electricity consumed in Brazil

3. BRAZILIAN NUCLEAR POLICE

Constitutional Articles 21 and 177, Nuclear energy should be used only for peaceful purposes. 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). Law 6189, December 1974, attributes to CNEN the responsibility for receiving, storing and final disposal of radioactive waste.

Resolution 199, July 2016 The UAS Licensing process must comply with the CNEN-NE-1.04 Licensing of Nuclear Facilities, and the specificities will be evaluated individually by the CNEN areas responsible for UAS licensing adopting as the standard model for the preparation of the Safety Analysis Report of the Dry Unit for Irradiated Fuel Assembly (UAS), the North American recommendation of the Nuclear Regulatory Commission, entitled Regulatory Guide 3.62 - Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Fuel Storage Casks.

Law Decree 9600, December 2018, establishes that spent nuclear fuel will be stored in an appropriate location with a view to future use of the reusable material.

4. SPENT FUEL ASSEMBLY (SFA) STORAGE AT CNAAA

Angra 1 NPP, a PWR, constructed with Westinghouse technology two-loop plant designed to gross output of 657 MWe, uses 16 x 16 Westinghouse fuel assemblies (STD, NGF).

Its commercial operation began on January 1985. In 1997 it had the capacity of its spent fuel pool increased to 1252 fuels, today it has 1018 of its cells occupied being predicted its depletion to December 2021.

Angra 2 NPP, a PWR, constructed with Siemens (KWU) technology, four-loop plant with gross output of 1350 MWe, uses 17 x 17 KWU - SIEMENS fuel assemblies (FOCUS, HTP).

Its commercial operation began on January 2001. It had the capacity of its spent fuel pool for 1084 fuel assemblies, today it has 949 of its cells occupied being predicted its depletion to December 2021.

5. STRATEGY TO STORAGE AFTER SPENT FUEL POOL DEPLETION

For the definition of the dry storage solution, ELETRONUCLEAR considered the safety, licensing and technology factors, which are widely used in the world, having as a limit the implementation period, technical feasibility, economic feasibility and environmental situation.

From the analysis of the above assumptions, ELETRONUCLEAR decided to adopt CANISTER-based storage for meeting all the factors described above to storage spent fuel on site (AR storage).

The Dry Storage Devices will be CANISTER-based system, provided with licensed by CNEN for initial-term storage system for SFA outside of the existing NPP spent fuels pools, but inside CNAAA.

All the activities including the transference of SFA from Angra 1 and Angra 2 NPPs to UAS, surveillance requirements and records management must be performed within licensable premises (CNEN standards and international requirements).

The Licensing Process based on the use of "General License" documentation prepared by HOLTEC and approved by the NRC (Nuclear Regulatory Commission) in the United States for generic use was a reference for the Brazilian Licensing.

CNEN established a procedure similar to Site Specific License in accordance with the Brazilian Standard CNEN-NE 1.04, and adopted the recommendation “Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Fuel Storage Casks” together with NUREG 1567 – “Standard Review Plan for Spent Fuel Dry Storage Facilities”.

In the period from 2007 to 2013 an extensive program of field geotechnical investigations and field and laboratory tests was carried out, as well as geophysical and geological-geotechnical investigations of semi-detail of the rocky wall.

The location set for the deployment of the UAS pad is located inside the site of the CNAAA, between the Angra 2 and Angra 3 Power Plants. The region is characterized by the existence of a rocky massif that plunges towards the sea. This location is shown in Fig. 1.

The CNAAA may be accessed by the Rio-Santos road (BR-101, at Km 132), and in case of equipment transport (including heavy equipment), by the harbor located in the bay quite close to the Angra 1 NPP, Equipment for Angra 1 and 2 were already delivered through this harbor.

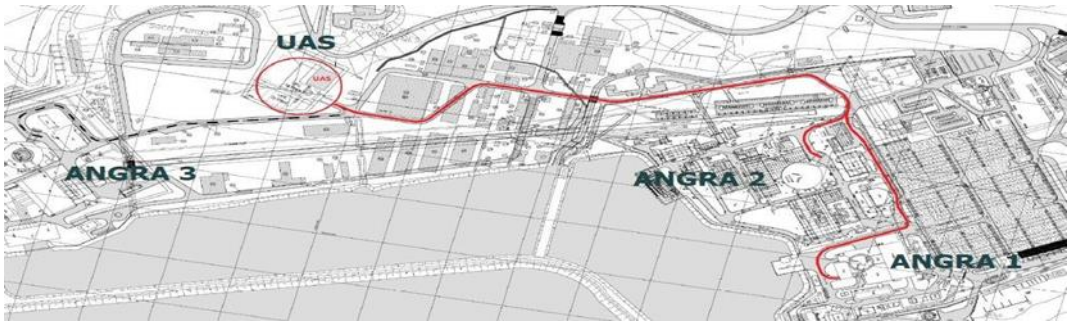

FIG. 1. Schematic diagram showing the location of UAS (ISFI) in CNAAA.

6. HISTORY OF UAS (ISFI) IMPLEMENTATION ON CNAAA

Since the start of the operation of the Angra 1 and Angra 2 plants, the SFA are stored in existing pools inside the plants, after burning inside their reactors. With the reduction of the space of these pools, ELETRONUCLEAR in early 2000, began designing a complementary installation to store SFA after the exhaustion of their spent fuel pools.

ELETRONUCLEAR, in 2006, presented its policy of Nuclear and Radioactive Rejects, with the definition of the construction of an installation external to the plants, using water as a cooling element and radiological-shielding, and installing similar mechanical systems for the removal of heat, to the existing ones in Angra 1 and Angra 2. In practice the installation would be an external unit with the same principles of the existing spent fuel pools, for which the company already had knowledge of the project and operation.

From that time, studies began to elaborate the conceptual design of a wet complementary unit of storage of irradiated fuel elements – UFC, being defined the place for the implementation of the UFC in the CNAAA.

In January 2014 was approved by the Executive Board of ELETRONUCLEAR the UFC Project Proposal.

In June 2015, after a strategic reassessment considering financial, technological and time aspects for the implementation of the UFC Unit, ELETRONUCLEAR decided to suspend the execution of the UFC venture and to adopt Dry Storage, with adequate solution for the storage of SFA.

February 2016, ELETRUNUCLEAR presented to IBAMA the Complementary Dry Storage Unit for Irradiated Fuel Elements - UAS, for 15 casks. July 2016, CNEN resolution 199, certified UAS solution following NRC Guides.

September 2016, ELETRONUCLEAR presented to CNEN the Local Report to UAS.

April 2017, ELETRONUCLEAR presented the Technical Specification for the UAS.

July 2017, a contract was signed with HOLTEC INTERNATIONAL for the installation of the first stage of the Dry Storage Unit and the transfer of 510 ECIs from Angra 1 and Angra 2 (total of 15 casks) to UAS, sufficient for the operation for about 5 years of each of the two power plants. October 2017, the ELETRONUCLEAR was approved the new Nuclear and Radioactive Rejects Policy, with the definition of Dry Storage for the storage of SFA of the plants. Thus, studies are initiated for the next stages of SFA transfers.

February 2018 - ETN submitted to IBAMA, the Simplified Environmental Report - RAS

September 2018, ELETRONUCLEAR approved an amendment to the contract with HOLTEC INTERNATIONAL to expand the capacity of the UAS from 15 to 72 Casks, which increases the capacity of UAS to 2.400 spent fuel assemblies which will be sufficient for storage for around 40 years contemplating the operation of the three units of the plant.

7. SCHEDULE OF NEXT ACTIVITIES FOR UAS IMPLEMENTATION

A schedule of activities was established with periodic monitoring highlighting the main milestones:

Nuclear Licensing – CNEN:

- Issuances of the building permit – March 2019.
- Issuance of the operating permit – June 2020.

Environmental licensing - IBAMA.

- Issuance of the installation license – March 2019.

Implantation – HOLTEC:

- UAS Pad Construction – April 2019;
- Conclusion of Project Modifications in Power Plants – May 2020;
- Commissioning (Dry runs – no fuel) – June 2020.

Transfer – HOLTEC:

- Angra 2 SFA exhaust – July 2021;
- Angra 1 SFA exhaust – December 2021.

8. PROCESSES CURRENTLY IN DEVELOPMENT

The short time to implement the complementary storage strategy is the main challenge to be met. Contingencies are being prepared to maintain the operation of the plants.

The contracted company HOLTEC is the executor of the whole process of implementation, commissioning and initial transfer with the participation of ETN in phases of design, engineering, manufacturing, construction, inspection, quality warranty, assembly, commissioning and final acceptance. During this process, specialists of ELETRONUCLEAR are being trained in order to enable the inspections, maintenance and future transfers.

Additional spaces, besides those reserved for unloading the reactor core, in the fuel storage pools of the plants, will be considered for the transfer of the elements stored in the canister in the event of the need to transfer these elements to other storage devices.

Initially it is planned to store only SFA without failures or storage restrictions, and studies are being carried out to verify the final destination of these SFA.

Data retention mechanisms are being studied for long periods of time in order to enable future queries of specific fuel storage data.