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IEA-R1 REACTOR - SPENT FUEL MANAGEMENT

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Abstract

Brazil currently has one Swimming Pool Research Reactor (IEA-R1) at the Instituto de Pesquisas Energéticas e Nucleares - São Paulo. The spent fuel produced is stored both at the Reactor Pool Storage Compartment and at the Dry Well System. The present situation and future plans for spent fuel storage are described.

1. INTRODUCTION

The IEA-R1 Swimming Pool Research Reactor is in operation since 1957. It was built within the "Atoms for Peace" program of the U. S. Government.

The IEA-R1 Reactor is presently operated approximately eight hours per day, five days per week, at power levels up to 2 MW thermal.

The present uses of the reactor are limited primarily to production of sealed sources, production of isotopes, production of neutrons for beam holes, and small sample irradiation for activation analysis. Neutronic and termohidraulic studies are also performed. A calculation methodology was developed to define the new core configurations.

Since 1985, the fuel elements to be used at the IEA-R1 Reactor are being manufactured by IPEN/CNEN-SP.

It is intended to improve the uses of the IEA-R1 Reactor with continuously operation periods of 48 hours per week. In a second step the operational period could be extended to five days continuously and this decision depends on the staff and fuel availability. Significant improvement for radioisotope production will obtained. It will be possible also to install in-core fuel test loops to the investigation of many aspects of fuel performance using short lengths of fuel rods and plates.

The spent fuel produced is stored at the Reactor Pool Storage Compartment and at the Dry Well System. The main aspects of the spent fuel management are briefly described in the next sections.

2. PRESENT STATE AND PERSPECTIVES

2.1 -At Reactor Wet Storage

The IEA-R1 Reactor has a spent fuel storage compartment at its pool. The reactor core pool area is connected with the spent fuel compartment through a canal lock. The entire pool has a stainless steel lining.

There are three units of fixed storage racks placed at the storage compartment (Figure 1). The total capacity of storage is 84 fuel assemblies, for fuel elements with cross section of 76.1x79.7 (mm^2). The pitch between the assemblies assure a deep sub criticality configuration without use of neutron absorber materials.

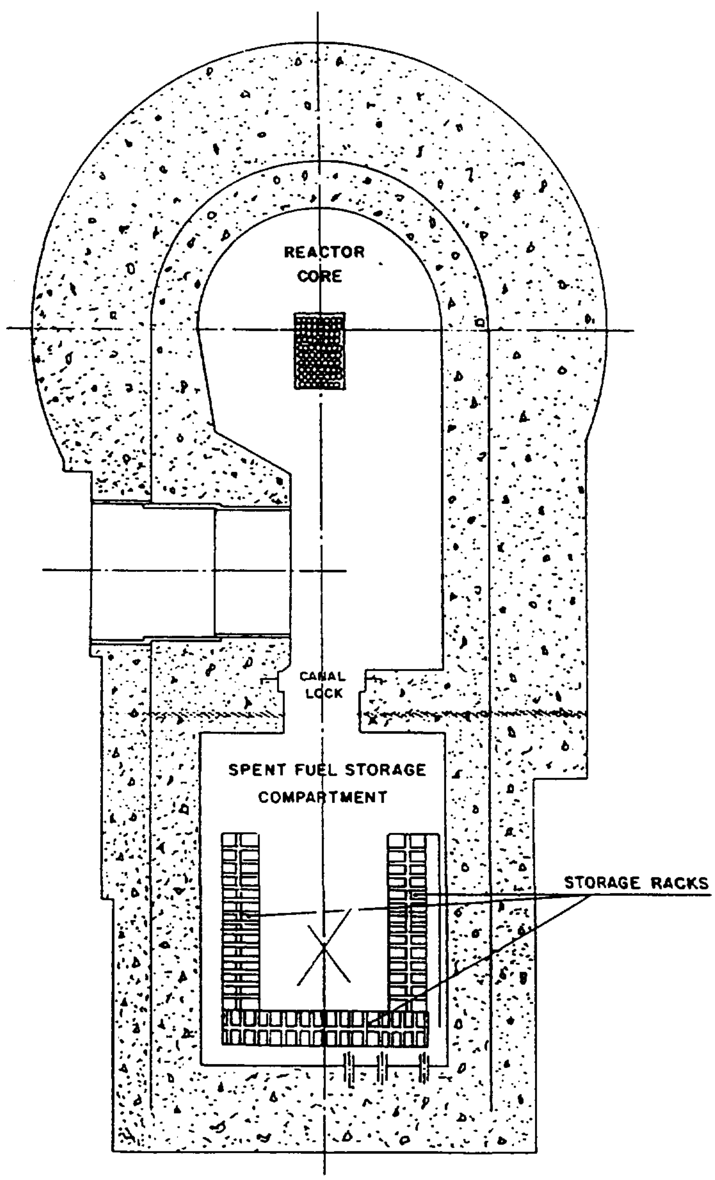

Figure 1:-Spent Fuel Storage Compartment

The water pH, conductivity and temperature are daily monitored.

The water activity is weekly monitored. Water is circulated about 10% of its total volume per week through a cationic resin. The water purification effectiveness is tested by monitoring individual radioactive nuclides (I^{131}, I^{133}, Te^{132}, Cs^{137} and Np^{239}).

Currently there are 71 spent fuel assemblies stored at the Reactor Pool Storage Compartment.

TABLE I - IEA-R1 WET STORAGE SITUATION - JUNE/94

LOAD No.	**FUEL DESCRIPTION**	**U^{235} (g) INITIAL**	**U^{235} (g) ACTUAL**	**BURNUP %**
2 "United Nuclear Corporat."	MTR type, U-Al alloy, 20% enriched in U^{235}, curved plate, 39 fuel elements stored (1959)	5728,78	4553,69	20
3 "United States Nuclear	MTR type, U-Al alloy, 93% enriched in U^{235}, plane plate, 30 fuel elements stored (1970)	4815,65	3006,94	37
5 "IPEN/ CNEN-SP"	MTR type, U_3O_8-Al dispersion, 20% enriched in U^{235}, plane plate, 2 fuel elements stored (1985)	121,20	100,20	17
TOTAL:	- 71 fuel elements stored - 13 free racks	10665,61	7660,83	-

2.2 - Away-from-reactor Dry Well Storage System

There are 50 storage pits at the Dry Well Storage System that is located at the first floor of the reactor building. The storage pits are arranged in three rows as showed in Figure 2. Each pit consists of a stainless steel tube, 2.0 mm tick, 150 to 200 mm of diameter and approximately 3,15 m of length. All tubes are connected to a ventilation system.

Presently, 25 storage pits have a water infiltration process. For this reason 12 empty pits of this group were sealed. The study of solutions to recover these pits are in progress.

There are 12 empty pits available to be used in the entire system.

There are 37 fuel elements stored at 13 storage pits. These fuels with 3 others more, stored at the reactor coffer, consist the first set of fuel elements received from Babcock & Wilcox Company.

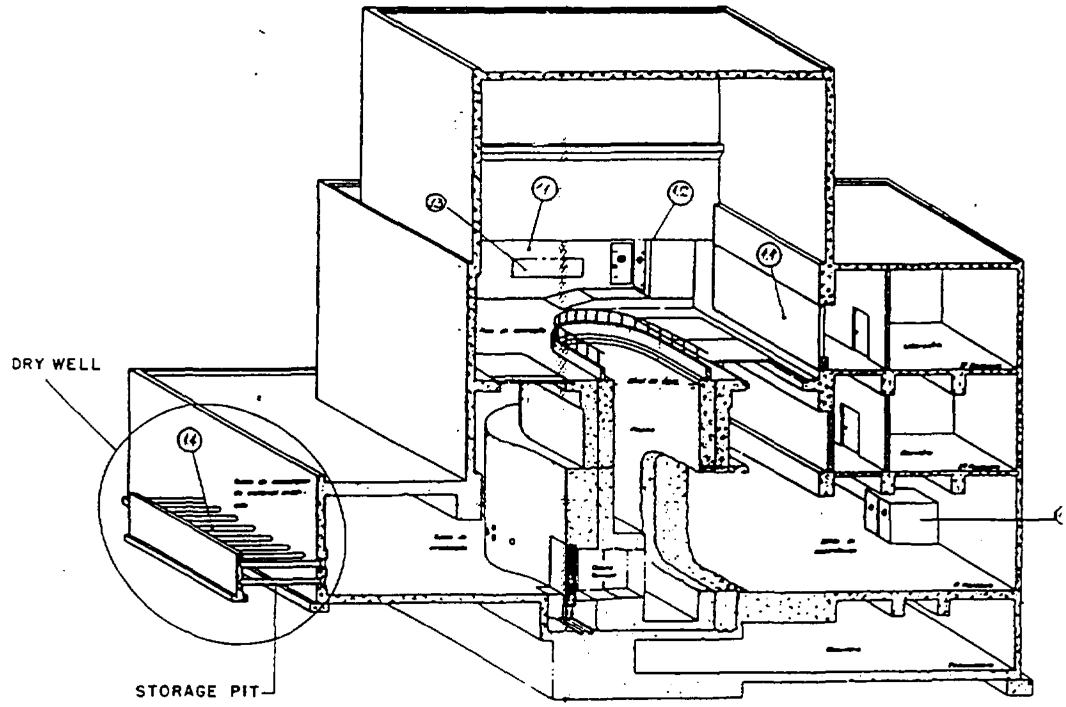

Figure 2:- Dry Well Storage System

These fuel elements were used for several core configurations at variable power levels up to 5 MW (during few hours). When the total core burnup of about 2 MWd was attained (December 1958), these fuel elements were putted out of use because at that time corrosion of some elements was evident. An individual sipping test was conduct and was observed that 10 between 35 of these fuel elements presented counting levels 10 times greater than the reference element, confirming a fail condition.

These defective fuel elements led to change the manufacture process of the second set of fuel elements. The main alteration of the second fuel set was that the fuel plates were not brazed at lateral support plate (like the ones of the first set), but fastened through a mechanical process.

TABLE II - IEA-R1 DRY STORAGE SITUATION - JUNE/94

LOAD No.	FUEL DESCRIPTION	U^{235} (g) INITIAL	U^{235} (g) ACTUAL	BURNUP %
1 "Babcock and Wilcox"	MTR type, U-Al alloy, 20% enriched in U^{235}, curved plate, 37 fuel elements stored at the Dry Well System and 3 at the reactor Coffer (1957)	5866,59	5864,07	0,04
TOTAL:	- 40 fuel elements stored - 25 storage pits out of use -12 storage pits are empty and available			-

2.3 - Perspectives

The 13 fuel elements from the third reactor load (93% enriched in U^{235}), that remaining in reactor core, have an average burnup about 46%. The limit of burnup allowed for the IEA-R1 fuel elements is 50% in weight of U^{235}. Thus, these elements shall leave the reactor core along of the next two years.

The 5 fuel elements from the fourth reactor load (20% enriched in U^{235}) have an average burnup about 42% and also shall leave the reactor core along the next two years.

The improvement of the reactor utilization require that the reactor must operate continuously at least 48 hours per week. At the present operational mode the depletion of U^{235} is about 160g/year. The two days continuously operation will result in a fuel depletion of about 200 g/year of U^{235}.

3. CONCLUSIONS

A periodic visual inspection of the fuel elements has shown that the corrosion resistance is satisfactory in the conditions of the IEA-R1 storage pool.

The actual wet storage capacity shall be upgraded in the next two years, due the fact that the remaining 13 free racks are not enough to receive all fuel elements with high burnup in irradiation at the reactor core. This upgrade will be obtained through the installation of an existent movable rack with 24 fuel assembly positions.

Even if the reactor mode operation to change in the next two years (48 hours continuously), with the above mentioned upgrade no problems of spent fuel storage are foreseen for the next 10 years. However, studies about the long term storage solutions will be performed as soon as the new operational mode begins (1995). It will be also performed a feasibility study of continuously five days operation regarding problems of staff, fuel supplying and spent fuel storage.

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