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IPR-R1 TRIGA RESEARCH REACTOR DECOMMISSIONING: PRELIMINARY PLAN

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ABSTRACT

The International Atomic Energy Agency (IAEA) is concerning to establish or adopt standards of safety for the protection of health, life and property in the development and application of nuclear energy for peaceful purposes. In this way the IAEA recommends that decommissioning planning should be part of all radioactive installation licensing process. There are over 200 research reactors that have either not operated for a considerable period of time and may never return to operation or, are close to permanent shutdown. Many countries do not have a decommissioning policy, and like Brazil not all installations have their decommissioning plan as part of the licensing documentation. The Nuclear Technology Development Centre (CDTN/CNEN) has a TRIGA Mark I Research Reactor in operation for 47 years with 3.6% average fuel burn-up. The original power was 100 kW and it is being licensed for 250 kW, and as no decommissioning policy was adopted, it needs to do the decommissioning plan for it now. This paper presents the description of IPR-R1 TRIGA reactor and the preliminary plan for its decommissioning, as part of the licensing requirements.

1. INTRODUCTION

All nuclear installations should be commissioned, and after their shutdown they should be decommissioned. There are many factors that bring to the decision to shutdown a nuclear installation, for example obsolescence, security, regulatory aspects, political changes, accidents, low performance, etc. There are over 200 research reactors that have either not operated for a considerable period of time and may never return to operation or, are close to permanent shutdown [1, 2].

Decommissioning is defined as all administrative and technical actions that should be taken at the end of a nuclear installation in order to assure the suitable physical and radiological protection to the workers, general public, and environment [3]. These actions allow also the removal of the installation from the regulatory control. This process involves two phases: decontamination and dismantling. The decontamination is the phase in which the complete or partial removal of contamination is done by a physical, chemical or biological process. The dismantling consists on the disassembly and removal of any structure, system or component during decommissioning. Dismantling may be performed immediately after permanent retirement of a nuclear facility or it may be postponed.

The decommissioning plan is the document, in which is organized all information about the proposed decommissioning activities for the facility. It allows the regulatory body to make a proper evaluation and to ensure that decommissioning of the facility can be performed in a safe manner. IAEA is concerned to establish or adopt standards of safety for the protection of health, life and property in the development and application of nuclear energy for peaceful purposes. In this way the IAEA recommends that decommissioning planning should be part of all radioactive installation licensing process. Many countries do not have a decommissioning policy, and like Brazil not all installations have their decommissioning plan as part of the licensing documentation.

Currently the search of the sustainable development proposes that the potential for redevelopment should not be ignored. Sustainable development implies the need to combine economic development with conservation of natural resources such as land. In the case of decommissioning, the recycling of land implied by redevelopment of a site offers a valuable means of avoiding the need to obtain further “greenfield” sites. This also implies economic development with the maintenance of social and community integrity. Both of these benefits can be attained by the sensitive and organized redevelopment of sites to provide continuity of employment and new production opportunities. Finally, the principles of sustainable development suggest a more transparent and participative decision making process than has been the practice to date in may aspects of nuclear development [4].

The Nuclear Technology Development Centre (CDTN/CNEN) has a TRIGA Mark I Research Reactor in operation for 47 years with 3.6% average fuel burn-up. The original power was 100 kW and it is being licensed for 250 kW, and as no decommissioning policy was adopted, it needs to do the decommissioning plan for it. This paper presents the description of IPR-R1 TRIGA Reactor and the preliminary plan for its decommissioning, as part of the licensing requirements.

2. IPR – R1 TRIGA REACTOR

The first and very important step to establish the decommissioning plan is to know and to define the installation to be decommissioned. The 250 kW TRIGA reactor (IPR-R1) is at the Nuclear Technology Development Centre (Centro de Desenvolvimento de Tecnologia Nuclear – CDTN) on the campus of Federal University of Minas Gerais, in Belo Horizonte, and is mainly used for research purposes. The first criticality was achieved on November of 1960. The regime of operation of the reactor is about 4 hours per day, 4 days per week, and 40 weeks per year. The integrated burn-up of the reactor since its first criticality is about 130 MW-Days. In the Fig. 1 is presented external and internal aspects of the TRIGA IPR-R1 reactor.

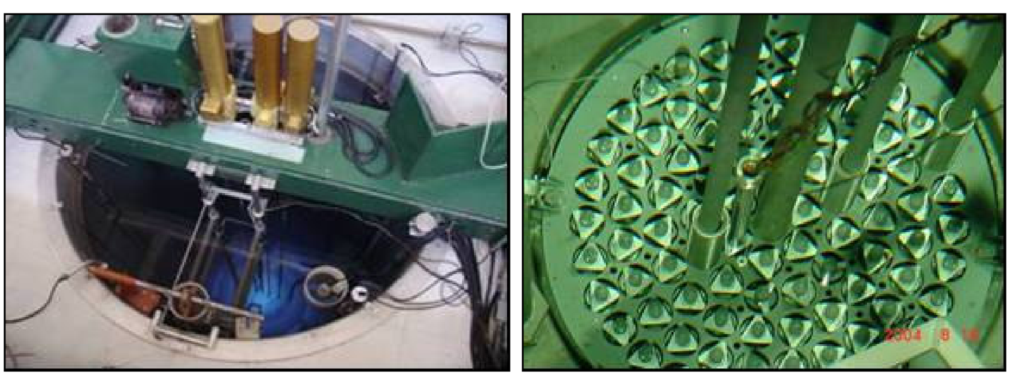

Figure 1. Top View of the TRIGA IPR-R1 Core

IPR-R1 Reactor TRIGA is installed in a building especially constructed to shelter it in a reinforced concrete structure. The main characteristics of the fuel element and of the reactor are presented in Table 1. The IPR-R1 has no short and medium range storage problems, due to its low nominal power. The first fuel assembly replacement is expected to occur only in 2010. In Table 2 is presented the IPR-R1 spent fuel assembly (SFA) inventory.

A policy regarding spent fuel or high-level waste disposal was not yet defined by Brazilian government. However, given that the legal framework regarding waste disposal is being defined, this issue will be discussed at the national level.

Table 1. Fuel element and reactor characteristics [5]

Fuel Element Type	*Aluminum*	*Stainless steel*
Number	58	5
Geometry	Cylindrical	Cylindrical
Active length	35.56 cm	38.10 cm
Cladding material	Aluminum 1100F	S. Steel AISI-304
Cladding thickness	0.07 cm	0.05 cm
Cladding diameter	3.73 cm	3.76 cm
Fuel diameter (U-ZrH)	3.56 cm	3.63 cm
Fuel-moderator material	$U\text{-}ZrH_{1.0}$	$U\text{-} ZrH_{1.6}$
Amount of U (% weight)	8.0	8.5
Enrichment (% ^{235}U)	20	20

Table 2. SFA inventory of the IPR-R1 Reactor

Facility	*# of FE in Present Core*	*SFA Storage*	
		At RR	*Away RR*
IPR-R1	63 rods	0	0

FE = fuel element RR = research reactor

3. DECOMMISSIONING PLAN

A plan shall be prepared to ensure safety and feasibility throughout the decommissioning. This plan shall be submitted to the safety committee and regulatory body for approval by before beginning of decommissioning activities. The decommissioning plan shall include an evaluation of one or more decommissioning alternatives suitable for the studied installation and that achieve the requirements of the regulatory body [1, 2, 4, 6]. Examples of alternative approaches to decommissioning are:

a) Protective storage in an intact condition after removal of all fuel assemblies and readily removable radioactive components and wastes;

b) Entombment of radioactive structures and large components after removal of all fuel assemblies and readily removable radioactive components and wastes; and

c) Removal of all radioactive materials and thorough decontamination of the remaining structures to permit unrestricted use.

3.1. General Aspects of a Decommissioning Plan

Aspects of the facility design shall be reviewed while developing the plan, mainly these ones that can optimize the decommissioning. It is also important to evaluate its operational history, including the changes in the geometry of the core, accidents, changes in the design, registry of the maintenance and operation of systems and equipment, registry of the development and techniques used during the shutdown for maintenance, occupational doses, experience of the personnel (documented), generated wastes evaluation etc.

The decommissioning plan shall include all steps that lead to eventual complete decommissioning to the point that safety can be ensured with minimum or no surveillance. These stages may include storage and surveillance, restricted site use and unrestricted site use. As the decision for the decommissioning often is made after a period of extended shutdown, occurrences during this period shall be considered when developing the decommissioning plan. It should be used the experience of the operation personnel. The waste estimation (volume, weight, activity, classification), which will be generated during the decommissioning, must be very well known before the establishment of dismantling plan is, because it is larger and different than that generated during the reactor operation and this must be in accordance with the repository design. Concerning to the waste no matter what is the decommissioning strategy, a factor that has a big influence in both economical and environmental aspects is to minimize (e.g. recycling and reusing) as much as possible the waste generation [1, 2, 6].

Procedures for handling, dismantling and disposal of experimental devices or other irradiated equipment that requires storage and eventual disposal shall be established in advance or if already constructed as early as possible. The purpose of the new technology and different approaches for the decommissioning is to reduce the occupational doses and generate the lesser environmental impact during the transference and removal of the materials and components. All activities during the decommissioning process shall be subjected to a QA program.

3.2. Documentation for Decommissioning Operation Licensing

Each licensee is responsible for ensuring that relevant national rules and regulations are applied to the circumstances of the facility being decommissioned. Nevertheless, the following contents shall be take part of the decommissioning documentation [1, 2, 6]:

- ✓ Introduction;
- ✓ Facility description: Physical description of the site and facility; operational history; systems and equipment; radioactive and toxic material inventory;

- ✓ Decommissioning strategy: Objectives; decommissioning alternatives; safety principles and criteria; waste type, volumes and routes; dose estimates; cost estimates; financial arrangements; selection and justification of preferred option;
- ✓ Project management: resources; organization and responsibilities; review and monitoring arrangements; training and qualifications; reporting and records;
- ✓ Decommissioning activities: description and schedule of phases and tasks; decontamination activities; dismantling; waste management; surveillance and maintenance programs;
- ✓ Safety assessment: dose predictions for tasks; demonstration of ALARA for tasks; radiation monitoring and protection system; physical security and materials control; management of safety; risk analysis; operating rules and instructions; justification of safety for workers, general population, and environment;
- ✓ Environmental impact assessment;
- ✓ Quality assurance program;
- ✓ Radiation protection and safety program;
- ✓ Final radiation survey proposal;
- ✓ Outline of the final decommissioning report: Summary of work; demonstration of compliance with requirements;
- ✓ Continued surveillance and maintenance and future decommissioning activities (deferred stages of decommissioning).

3.3 IPR-R1 Decommissioning

The guidelines for IPR-R1 decommissioning are:

a) It will be followed the safety and environmental principles defined by they regulatory bodies;

b) The preliminary qualitative inventory of radiological and toxic material consists on concrete, aluminum and stainless steel tubes, bombs, fuel elements cladding of Al and stainless steel, U, fission products, Zr, graphite, boron carbide.

c) The procedures for radioactive waste management of CDTN and IAEA will be used. For the hazardous and regular wastes it will be used the procedures established by the environmental institution.

d) As options for the decommissioning can be considered: removal of the fuel assemblies and decontamination for following restricted uses or removal of all radioactive materials and thorough decontamination of the remaining structures to permit unrestricted use.

e) Just little time before the shutdown the decommissioning will be selected in accordance with the actual legislation, and the political and economical situation. As the reactor is at CDTN`s site probably the strategy will be: take off the fuel elements and the interns of the reactor. The concrete will be classified and the area can be used for other applications, because the core is in an excavated hole.

f) The packages will be selected among the qualified ones, in accord of the waste to be conditioned.

g) The equipment and staff requirements will be defined depending on the decontamination activities and on the material defined as radioactive waste.
h) The safety and environmental assessments will be done by CDTN´s radiological and environmental protection staff, respectively.
i) Costs should be estimated in advance, so that it would be provided the necessary budget.
j) A special report with the decommissioning plan should be prepared and sent to the regulatory body just before the reactor shutdown requesting the license for that.

4. CONCLUSIONS

The decommissioning plan should take part of the documentation presented to commission nuclear installations. The IPR-R1 a research reactor operating at CDTN/CNEN is being commissioned for 250 kW. The draft of the decommissioning plan for it is being written.

The decommissioning plan should take part of the documentation presented to commission nuclear installations. In the initial IPR-R1 licensing, the decommissioning aspects were not considered and no decommissioning plan was developed during the commissioning activities. Nowadays, the reactor operating at CDTN/CNEN is being commissioned for operation in 250 kW. The draft of the decommissioning plan for it is being written and will take part of this new licensing documentation.

This documentation regarding to the decommissioning planning can be used as a baseline or guide for other radioactive installation either for licensing future processes or for revision of existent documentation.

5. REFERENCES

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