**DECOMMISSIONING AND ENVIRONMENTAL REMEDIATION PLANNING FOR A RESEARCH REACTOR IN NIGERIA**

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**Abstract**

Centre for Energy Research and Training (CERT), operates a Research Reactor codenamed NIgeria Research Reactor-1 (NIRR-1). The reactor was commissioned February, 3 2004. The designed and operation of the NIRR-facility are based on both national and international regulations and safety standards. Thus at end of its lifetime, the facility shall be decommissioned so that the site will become safe for other use(s) and all items removed are secured. This paper presents overview of decommissioning and remediation plan of the facility with respect to organizational, technical, safety, and security as well as the legal and institutional framework.

1. INTRODUCTION

**1.1. Facility location and description**

NIRR-1 is located at and operated by CERT, ABU, Zaria. It is a tank-in-pool type, low-power Miniature Neutron Source Reactor (MNSR) with Nominal thermal power is of 31 kW, having low critical mass (about 1 Kg) of 235U enrichment > 90%, U-Al4 in a compact core and reflected on the side and the bottom by, annular beryllium and beryllium disc respectively. The core is in a cylindrical alloy vessel with total height of 5.62 m, inner diameter of 0.6 m and a thickness of 10 mm. It uses light water as moderator and coolant. The reactor vessel is immersed in a pool of diameter, 2.7 m, and a depth of 6.5 m. The pool is made of reinforced concrete structure with walls of 400 mm thick and bottom lining resting on 500 mm thick concrete. There are auxiliaries such as water purification, production and gas purge systems attached to the reactor. The reactor’s main uses include neutron activation analysis, research and teaching, with limited isotope production capability.

2. DECOMMISSIONING OF NIRR-1

NIRR-1 is designed, constructed and operating with its decommissioning plan, particularly the spent fuel. At the expiration of reactor operation’s licence, the operator is responsible for all aspects of a site’s decommissioning, to make it permanently safe and perhaps restore it for reuse with no possible significant risk neither on public nor the environment.

**2.1. Decommissioning strategy**

NIRR-1 will be dismantle/decommissioning immediately after its closure in order to benefit from the knowledge, skills and availability of the existing operations and maintenance staff. The spent fuel will be shipped back to its vendors the Chinese Institute of Atomic Energy (CIEA).

**2.2. Decommissioning plan**

According to NIRR-1, Safety Analysis Report (SAR), the decommissioning shall be carried out according to a duly approved decommissioning plan. The plan shall be flexible and adaptable in pursuing the essential objectives of safety and restoration [3].

**2.3. Decommissioning process**

 The decommissioning process involves the following steps;

1. Provision of necessary equipment at installation to facilitate decommissioning;
2. Ensuring that activities during the operational life time of the NIRR-1 include consideration for decommissioning requirements;
3. Preparation of a detail decommissioning plan;
4. Review of the decommissioning plan;
5. Approval of the decommissioning plan;
6. Supervision of the decommissioning plan; and certification that the decommissioning has been satisfactorily completed.

**2.4 Main equipment provided at installation**

 The equipment provided at installation that would facilitate decommissioning are;

1. A 3-tonne crane mounted in the reactor hall with a long handle tool to manipulate the NIRR-1 fuel cage, two 1.5-tonne cranes in the water purification room and another 1.5-tonne crane in the gas purge room;
2. Long handle tool for removing the fuel cage;
3. A waste management facility on site; and
4. A mechanical workshop on site.

**2.5 Review of plan**

 The decommissioning plan shall be submitted for review by the Reactor Safety Committee. The reviewed decommissioning plan shall be sent to the Nigerian Nuclear Regulatory Authority (NNRA) for approval. The plan is currently under review in order to meet up to international best practices in D&ER similar nuclear facility. The main considerations are core unloading and the storage and transport of radiation sources. During these operations, the relevant regulations on critical safety, radiation protection and transport of radioactive materials shall be adhered to strictly in order to ensure the safety of both personnel and equipment. Others include details of NIRR-1 site remediation, procedure for radiological/non- radiological characterization and everything directly/ indirectly related to the facility as well as cost analysis and funding.

**2.6 Waste Management**

NIRR-1 decommissioning waste as in similar research reactors is activated concrete rubble and steel materials, in many cases in the category of low level radioactive waste with long half-lives (due to 152Eu, 166mHo, 3H, 36Cl), whose disposal is expensive and problematic due to the extremely long times involved. The solid waste to be generated as an inevitable consequence of the decommissioning activities would be systematically categorized, processed, compacted and packed in specially marked steel drum. High level wastes drums are to be first stored in a storage pit within the reactor hall while others would moved to low level waste management facility at the Centre , until it is finally disposed of at approved endpoints. Associated liquid wastes would discharged to a liquid waste storage tank, where its radioactive contents shall be monitored and only discharged to sewage system if within acceptable levels as specified in the reviewed NIRR-1 decommissioning.

**2.7. Legal and institutional framework**

The main legal and institutional framework for nuclear related activities include D&ER are contained Nuclear Safety and Radiation Protection Act No. 19 of 1995 [2] and other regulations that are set by the regulatory authority. However D&ER regulation need to be review to meet up internal best practices.

3. CONCLUSIONS

NIRR-1 decommissioning plan is flexible based graded approach, clear and consistent for both safe and cost effectiveness according to national regulations and safety standards. The reviewed NIRR-1 decommissioning plan will meet up to international D&ER best practices for similar nuclear facility.

**REFERENCES**

[1] FEDERAL REPUBLIC OF NIGERIAN, Atomic Energy Act No. 46 of 1976

[2] FEDERAL REPUBLIC OF NIGERIAN OFFICIAL GAZETTE, Nuclear Safety and

Radiation Protection Act No. 19 of 1995, Supplement to Official Extraordinary No. 18, Vol. 82 (1995)

[3] CENTRE FOR ENERGY RESEARCH AND TRAINING, AHMADU BELLO UNIVERSITY, ZARIA, Nigeria Research Reactor-1, Final Safety Analysis Report (2005).