REPORT ON IMPLEMENTATION OF RAF 1007 IN NIGERIA

(STRENGTHENING THE CAPACITIES OF RESEARCH REACTORS FOR SAFETY AND UTILIZATION)

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Presentation Framework

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INTRODUCTION
A) COUNTRY: NIGERIA
B) PROJECT CODE: RAF 1007
C) PROJECT TITLE: Strengthening the Capacities of Research Reactors for Safety and Utilization.
D) PERIOD COVERED: 2018-2021
E) NATIONAL PROJECT COORDINATOR: Prof. S.P. Mallam
F) PROJECT COUNTERPART: Yusuf A. Ahmed (Appointed 12 April, 2018 -- Utilization)
G) SECOND COUNTERPART: Sunday A. Jonah (Appointed 13 April, 2018 -- Safety)
INTRODUCTION-NIRR-1

- 1995: Submitted IAEA-TC project for NIRR-1 HEU core
- 1996: PSA signed August 29, 1996; tripartite agreement (China, IAEA & Nigeria)
- Oct - Dec 1997: Factory training of 8 staff at CIAE in China ZPT & on-site construction started
- 2001: Activation of NNRA, which stalled hot commissioning in 1999
INTRODUCTION-NIRR-1

- Dec 2003 – Mar 2004: On-site commissioning,
- 1st criticality at noon on Feb. 03, 2004
- 2006 – 2012: IAEA CRP on Conversion feasibility studies
- 2015 to 2018: NIRR-1 Conversion
National Objectives

- Review and **expand linkages and collaborations** with national and international agencies and institutions on safety and utilization.
- Further **explore the potential utilization capabilities** of the reactor especially in Agriculture and Mining and match reactor capabilities to stakeholders/users’ needs.
- **Perform self-assessments** of the reactor from time to time and implement safety improvements based on the results including INSARR Missions, RASCA and Periodic Safety Review Missions.
- Refocus the reactor to be a tool that can help with development and/or preservation of practical competencies and that can **provide safety and utilization learning inputs for National Nuclear Training Programs**.
- Deployment, further improvement and **expansion of the E-learning courses and tools** especially in the area of safety and utilization.
NATIONAL OBJECTIVES - Performing self-assessments and implementing safety improvements

Methodology
- Performing self-assessments of the reactor safety, including preparing and conducting the self-assessment and use of a graded approach;
- Analyzing the results of self-assessments and developing and implementing action plans for safety improvements;
- Self-assessment as a tool to prepare for receiving IAEA peer review service;
- Leadership and management for safety.

Areas of concentration
- Updating and Conducting Safety Analysis;
- Operational Limits and Conditions;
- Ageing Management;
- Reactor Modifications;
- Utilization and Experiments;
- Integrated Management System;
- Operational Radiation Protection.
Technical Staff Availability and Strategic Action Plan

Technical Staff Availability
- **35 Scientist/Research Fellows**: BSc = 2, MSc = 12, PhD = 21
- **40 Technicians and Technologist**: Ordinary Diploma = 10, Higher Diploma = 7, BSc = 7, MSc = 13, PhD = 3

Strategic Action Plans
- To design and establish a research and safety training package aimed at assisting Nigeria’s nuclear power program.
- To intensify the efforts at sourcing and stocking of relevant spare parts and consumables to reduce down time & enhance age management.
- To review and implement a comprehensive maintenance programmer to sustain an effective maintenance culture.
- To evolve and develop programmes aimed at reassuring Nigeria and international communities on the safety and security of the reactor.
- To review and redesign NIRR-1 Safety and Utilization Program to make it more responsive.
- To review and refocus staff development programme through training and retraining in order to achieve a balance between competence and performance.
- To design and develop programmes aimed at creating standard and safety awareness among staff and strict adherence to procedures.
Project Strength, Weaknesses, Opportunities and Threats

**STRENGTH**
- Existence of suitably qualified research and technical staff
- Existence of a Miniature Neutron Source Reactor on the country
- Existence of independent nuclear regulatory body

**WEAKNESS**
- Poor funding from Federal Government of Nigeria
- Provision of services to clients is very weak
- Lack of Training and Consultancy Programmes

**OPPORTUNITIES**
- Active membership of AFRA-Regional Advisory Safety Committee in Africa (RASCA)
- Memorandum of Understanding (MOU) for training and utilization of NIRR-1 with:
  - University of Addis Ababa, Ethiopia
  - University of Gondar, Ethiopia
  - Sudan Atomic Energy Commission
  - Some Nigerian Universities

**THREATS**
- Ageing of facilities and manpower
- Slow implementation of Multipurpose Research Reactor Project
- Weak local patronage of nuclear services and external influence
SAFETY LESSONS LEARNED
FROM NIRR-1 CONVERSION
NIRR-1 CONVERSION REPORT FOR LEU 13%

- The HEU core was replaced by LEU fuel consisting of UO$_2$ with nominal enrichment of 13%.

- Preliminary SAR report was submitted to NNRA and already approved

- The PSAR contains the results of design, safety, and accident analyses performed for the conversion.

- The major changes are to:
  - Replacement of the HEU fuel pins with LEU fuel enriched to 13% in U-235,
  - increase in the diameter of the cadmium absorber central control rod and
  - increase in the operating power level from 31 kWth to 34 kWth
ZERO POWER EXPERIMENTS

- Off site ZPT experiments were performed at the ZPT Facility (ZPTF), China May 7-19, 2018
- The measured ZPT data compared well with the PSAR values
ZERO POWER TEST MEASUREMENTS

OFFSITE-CHINA
- Critical experiment using rod elements method
- Worth of fission chambers and tubes
- Worth of fuel element
- Worth of control rod
- Worth of top Beryllium shims
- Neutron flux distribution in the reactor core
- Worth of inner irradiation tubes
- Worth of outer irradiation tubes

ONSITE-NIGERIA
- Critical experiment was done to bring reactor to criticality at zero power using the water addition method
- Reactivity adjustment is 3.97 mk
- Neutron flux measurement in the inner irradiation tube; is approx. $1.0 \times 10^{12} \text{n/cm}^2\text{s}$
- Full power operation, 34 kW;
- Reactivity release experiments for core excess reactivity insertions (step & ramp)
- Detailed Commissioning tests results available
SAFETY REVIEW ACTIVITIES

- Core Removal program and procedure with schedules, sequencing of all activities and interdependences
- Qualification of tools and calibration of equipment
- Control system interlocks and logic checks
- Testing of emergency shutdown systems and precautions for not dropping foreign objects in vessel
- Radiation Emergency Drill
- Conduct of dry-run before core removal with actual vehicles, cranes and men to ensure reliability

SAFETY DOCUMENTATIONS

- Review of reactor safety, quality assurance and operating documents
- Review and analysis of all PIEs established by IAEA SSG-20 as applicable to NIRR-1
- Review and revise the procedure for response to emergency in NIRR-1
- Preparation of document that will guide dose mapping of the reactor internals, vessel, pool, water activity after removal of HEU
- Development of a program for monitoring effluent release through air
- IAEA Safety Mission
LESSONS LEARNED2 - CRITICAL AUTHORIZATIONS

MAJOR LICENSING IN NIGERIA
- Notification of conversion of NIRR-1
- Approval for site modification
- Notification on Status of HEU Fuel
- Approval/certification for TUK 145/C
- Approval/certification for ES3100
- License to Export Nuclear Material
- Approval to import/export dual use equipment
- License to Import LEU Material
- License to Transport Nuclear Material
- Approval to shutdown of NIRR-1 for conversion
- License to Handle and Use Nuclear Material
- License to Commission NIRR-1
- NIRR-1 License to operate with LEU
- Operator License for LEU

LICENSES OUTSIDE NIGERIA
- TUK 145/C license in Russia
- TUK 145/C license in China
- Expert Assessment Report on the safety of TUK 145/C for shipment of irradiated HEU core and fresh fuel pins
- Licensing of a Nigerian in USA on operation of ES3100
- Flight and Landing permits
- Fuel Data Analysis with Russia
- Fuel Data Analysis with China
- Road Transport and Min of Environment approval in China
- Tools and Equipment export in China and Nigeria
- HEU Import approval in China
- MOU with China
- PSA with China and IAEA
- Customs Exemptions
LESSONS LEARNED - TRAININGS AND SUB-CONTRACTORS ACTIVITIES

TRAINING OF PERSONNEL
- Training of CERT Personnel on Radiation Protection in Hungary
- Training of CERT Personnel on core discharge in Ghana
- Training of CERT personnel on underwater camera
- Witnessing of CERT Personnel to Ghana core removal, core loading, core transfer to China, and commissioning
- Training of Nigerian Security Personnel on Transport of Radioactive Materials
- Security personnel visit to Airport to assess facility

SUB-CONTRACTORS ACTIVITIES
- China supply and installation of reactor components
- SOSNY modification to the frame of ITC system to accommodate higher operating position when using the grapple
- SOSNY fabrication of additional winch for use in shipment
- SOSNY repair of the damaged winch
- SOSNY transfer of training equipment to Ghana - done
- UJV transfer of equipment to Nigeria
PROJECT EVALUATION
EVALUATION (Safety)

1. WORKSHOP ON SELF-ASSESSMENT OF RESEARCH REACTOR SAFETY, VIENNA, AUSTRIA (6-9 March, 2018)- Nuruddeen Abubakar
   - The discussions in the working groups focused on the results of self-assessments, feedback on self-assessment process and action planning for implementing safety improvements. Implementation in Progress

2. MEETING OF THE REGIONAL ADVISORY SAFETY COMMITTEE FOR RESEARCH REACTORS IN AFRICA (RASCA) CAIRO, EGYPT (1-5 JULY 2018)- Iro Yusuf
   - The outputs of the meeting are:
     - Meeting report addressing common issues in the region related to operating experience feedback programs and periodic safety review for research reactors and ways to address these issues by the participating Member States, with a focus on the role of the safety committees of operating organizations.
     - The report also addressed the results of the walkthrough of the ETRR-2 and Work plan for RASCA for 2019.
     - Lessons Implemented (pre-conversion and post conversion assessments)
The main outputs of the workshop were:

- Feedback, conclusions and recommendations following the testing of the existing material and the integrated self-evaluation approach.
- The workshop also contributed to further improvement and expansion of the E-learning course.
- It has promoted international cooperation and the development of a stronger user community, as well as contributed to experience preservation and knowledge management NAA.
- The information and workshop materials were compiled and made available through the IAEA portal to all known NAA practitioners worldwide.

**Implementation in progress**
Accomplishments/Achievements - utilization

- Cooperation/collaborative activities
  - Implementation of IAEA E-learning tools started
  - Memorandum of Understanding (MOU) for training and utilization with the following institutions:
    - Nigerian Universities (PhD and MSc Students work)
    - University of Addis Ababa, Ethiopia
    - University of Gondar, Ethiopia
    - Sudan Atomic Energy Commission
    - Ghana Atomic Energy Commission

- Participation in IAEA Proficiency testing since 2010 - good results

- Nigeria Inter-agency grant for In-house standards development
Accomplishments/Achievements - safety

- **Cooperation/collaborative activities**
  - Implementation of Periodic safety review using the provisions of the IAEA Safety Standard Series No. SSG-25 using a graded approach
    - Gradual implementation of Integrated Management System in NIRR-1
  - Implementation of RASCA recommendations
  - Implementation of INSARR Mission recommendations in Progress
  - Bilateral Safety Review Activities (Ghana-Nigeria)
  - Implementation of pre-Conversion IAEA Safety Mission recommendations
- **In-house Self Assessment** before and after conversion of NIRR-1
- **Successful conversion of NIRR-1 & its return to operation with 34 kW power**
SOURCES OF FUNDING FOR IMPLEMENTATION OF RAF 1007

- IAEA TC Projects and AFRA support
- Federal Government of Nigeria through the Nigeria Atomic Energy Commission, Abuja
- Provision of NAA services to clients
- Training and consultancy programs
- Grants and donations from industries, cooperate organizations and individuals
- Fees and charges from teaching, research and dosimetry services
- Diversification and utilization the skill, services and research facilities
LOCAL CONSTRAINTS AND THEIR IMPACT ON THE PROJECT

- Poor funding of institutions by government
- Slower pace in development of business plans
- Lack of spare parts for maintenance
- Lack of standard reference materials for utilization
- Lack of patronage from local industries
- Regulatory licensing bureaucracy
- Inadequate Postgraduate Training of Staff at reputable institutions
- Lack of support for Short term and long term fellowship training of young staff
FUTURE PLANS
FUTURE MANPOWER DEVELOPMENT FOR SUSTAINABILITY

- Developing manpower in some selected fields to replace the ageing ones for safe management and effective utilization of NIRR-1 and associated facilities,

- Postgraduate training of Staff at reputable institutions with reactor facilities

- Fellowship training of younger staff at similar and bigger reactors

- Participation of staff in IAEA and AFRA workshops and trainings
2019-2020 WORK PLAN

- Conducting post-conversion safety review
- Implementation of Integrated Leadership and management systems for safety of NIRR-1 and its auxiliary facilities for utilization
- Provision of self-learning and E-learning opportunities, and the promotion of NAA applications to end users and practitioners
- To review and expand linkages and collaboration with national and international agencies
- To prioritize updating of decommissioning plan and ensure implementation of its funding elements
- To put in place activities aimed at convincing government to sustain support for Nuclear Applications & Nuclear Safety.
- Ensure sustainability of National Nuclear Institutions by developing business plans and expanding the capabilities on INAA techniques
- To foster and increase human capacity building in the area of reactor safety and utilization by organizing education and training courses on safety and utilization
CONCLUSIONS AND RECOMMENDATIONS

- The full commitment and dedication of Project Coordinator and supporting staff is necessary and important.
- For the successful implementation of the project there is need for dissemination of information on project activities among end-users including notification for technical meetings, workshops and training.
- Adequate human and financial resources to be made available to nuclear institutions implementing the project.
- Institutions to identify, diversity and utilize the skill, services and research facilities.
- Institutions to expand research areas to include safety and utilization so as to meet the challenges of nuclear science and technology.
- There is need to ensure that reporting obligations are respected.
- Commitment of institutions to share facilities and expertise with all participating countries is important to the success of the project.
- IAEA to create further opportunities for Member States without reactors to access and utilize research reactors for human capacity building and knowledge management.
Nothing is urgent unless done safely!!

THANK YOU