CONSIDERATIONS FOR THE DESIGN AND IMPLEMENTATION OF PHYSICAL PROTECTION FOR A PROPOSED MULTI-PURPOSE RESEARCH REACTOR COMPLEX (MPRRC)

Ofodile O.N. and Agedah E.C.

Nigeria Atomic Energy Commission, No. 9 Kwame Nkrumah Crescent, Asokoro, Abuja FCT, Nigeria

onofodile@nigatom.org.ng, ebisomu.agedah@nigatom.org.ng

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{Summary}

In the recent past, many research reactors were designed to fulfil a wide variety of specific purposes, such as training, research and education, radioisotope production etc. This diversity complicates any effort to have a standard approach to the security of such research reactors. The situation is made worse due to the prevalent security threats to nuclear facilities all over the world.

Despite this difficulty, Nigeria has designed a physical protection system for the proposed Multi Purpose Research Reactor Complex (MPRRC). For the considerations of the physical protection system, Chapter 4 of the IAEA's draft document on the Developing, Implementing and Maintaining an Integrated Physical Protection System for the Physical Protection of Nuclear Material and Nuclear Facilities (Implementation of INFCIRC/225/Rev. 5) – NST023 of July 2014 emphasizes that it is a good practice to start integrating the design of the PPS against both unauthorized removal of nuclear material and sabotage of a nuclear facility into the overall facility design as early as possible in the design process. This is the case with the proposed MPRRC.

The security consideration for the siting of the proposed MPRRC takes into cognisance pertinent geographical features that enhance security of the facility in addition to other human and environmental factors.

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To counter potential external threats to the MPRRC, measures include amongst others:

- **The erection of guard towers to enable guards have a 360-degree and long distance viewing of the site surroundings by exploiting the gently sloping nature of the area.**
- **Biometric access control to the secluded MPRRC area at the Access Control Building (ACB) and Access Control Points (ACPs).**
- **Deployment of well-trained unarmed guards, armed guards and response forces to the MPRRC area in conjunction with the Office of the National Security Adviser (ONSA).**
- **Availability of armed response organisations who are located within reasonable distances to the site and can be brought in when and if the need arises.**

Finally, the organization and staffing levels of the MPRRC takes security into account and it includes the access, authority, and knowledge of facility employees and other vendors or inspectors who would have routine access to areas within the MPRRC's Protected Area (PA).

To be employed at the MPRRC, employees must undergo trustworthiness checks while some personnel will be on HRP and be granted a security clearance based on the access required to perform their duties.

Some of the supervisors would also be trained in Behavioural Observation Programme (BOP) which qualifies them to detect individual behavioural changes, which, if left unattended, could lead to threats to the safety or security of the facility or its employees.

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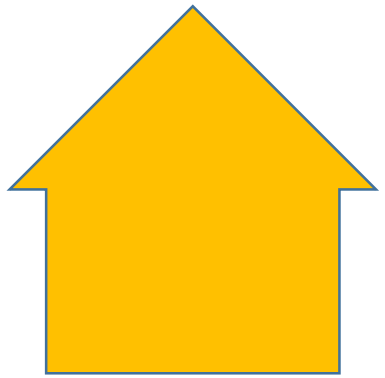

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{Introduction}

In the recent past, majority of research reactors were not designed with security as one of the major areas of concern. In fact, research reactor designs were typically optimized around their specific objective such as training, research and education, radioisotope production, medical therapy etc. This diversity of objectives complicates any effort to have a standard approach to security. The focus on these objectives often led to the inclusion of features that are not conducive for nuclear security. These features may provide security vulnerabilities that could be exploited by an adversary intent on committing unauthorised removal or sabotage. It is therefore important for anyone interested in the security of research reactors to consider all the related security concerns.

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{Introduction}

Thus, Nigeria, through the Nigeria Atomic Energy Commission (NAEC), has designed a physical protection system for a proposed Multi-Purpose Research Reactor Complex (MPRRC) that integrates equipment, personnel and processes. The overall objective is to protect persons, property and the environment from malicious acts involving nuclear material and other radioactive materials. This is in keeping with the IAEA's INFCIRC/225 Rev 5 which emphasizes that a Member State's "physical protection regime" should put in place measures aimed at guarding against unauthorized removal or sabotage of nuclear material and nuclear facilities. Hence, the key to Nigeria's physical protection system for the proposed MPRRC is taking into cognizance aspects of nuclear security as shown in figure 1.

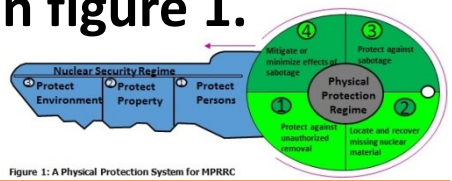

Figure 1: A Physical Protection System for MPRRC

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{Introduction}

For the enthronement of a strict nuclear security regime, Nigeria, in implementing its nuclear energy programme:

- **Is in compliance of all relevant treaties and international conventions and in partnership with the international community.**
- **Is domesticating all the relevant international treaties and statutes including the Convention on the Physical Protection of Nuclear Materials, 2005 which regulate the use of nuclear materal.**

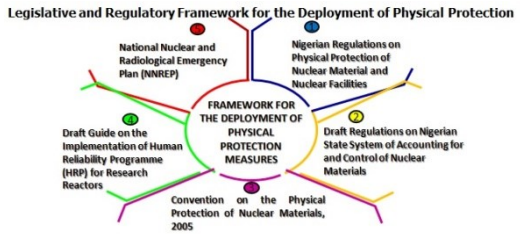

Figure 2: Physical Protection Enabling Framework

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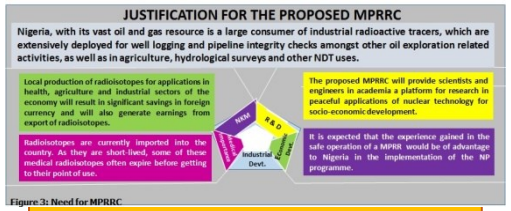
{The Need for a New MPRRC}

Nigeria currently has only one research reactor, a 30kW miniature neutron source research reactor (MNSR), located at the Centre for Energy Research and Training (CERT), Ahmadu Bello University, Zaria. The MNSR has been successfully operated since 2004, and is currently undergoing procedures for core conversion from HEU to LEU fuel. However, the capabilities of the MNSR are limited to training and neutron activation analysis. The quest for a new research reactor for multipurpose applications stems out of the limitations of the MNSR. Specifically, the new research reactor is envisaged to be a 10MW reactor and also an IAEA's basic Category III – handling Multi-Purpose Research Reactor Complex (MPRRC) which would be of immense benefit to the country in particular and the West-African sub-region in general. This assertion is based on the following:



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{The Need for a New MPRRC}

The proposed MPRRC is expected to provide services in the following main areas:

- **Irradiation applications, such as for production of radioisotopes, analytical techniques such as NAA, and neutron transmutation doping.**
- **Beam-port applications, including radiography, materials structure studies, prompt gamma neutron activation analysis, etc.**
- **Training and manpower development in support of the national nuclear power programme.**

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{Considerations for the Physical Protection of the New MPRRC}

Paragraphs 3.23 to 3.30 and Sections 4 and 5 of NSS 13 provide the responsibilities of the licence holders as well as the requirements for measures against unauthorised removal of nuclear material and sabotage of nuclear facilities respectively. Specifically, paragraph 3.8 states that:

"For a new nuclear facility, the site selection and design should take physical protection into account as early as possible and also address the interface between physical protection, safety and nuclear material accountancy and control to avoid any conflicts and to ensure that all three elements support each other"

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{Considerations for the Physical Protection System (PPS) of the New MPRRC}

As stipulated in Chapter 4 of the draft document on the Developing, Implementing and Maintaining an Integrated Physical Protection System for Nuclear Facilities of the "Physical Protection of Nuclear Material and Nuclear Facilities (Implementation of INFCIRC/225/Rev. 5) – NST023 of July 2014":

"A good practice is to start integrating the design of the PPS against both unauthorized removal of nuclear material and sabotage of a nuclear facility into the overall facility design as early as possible in the design process. Early consideration includes making decisions concerning siting and layout of the facility taking account of how they may influence the design and effectiveness of physical protection systems. It is important to minimize conflicts with other design requirements while taking advantage of opportunities for complementary and synergetic design, for example by engineering out potential vulnerabilities".

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{Considerations for the PPS of the Proposed MPRRC}

The considerations therefore for the Physical Protection Regime of the MPRRC are based on:

- **Physical Protection System (PPS).**
- **Nuclear Material Accounting and Control (NMA&C).**
- **Trustworthiness/Human Reliability Programme (HRP).**
- **National Nuclear and Radiological Emergency Plan (NNREP).**
- **Siting and Security.**

The considerations for the PPS, NMA&C and HRP are covered through IAEA's and Nigerian Nuclear Regulatory Authority (NNRA)'s guidance documents and regulations respectively, while the NNREP was prepared by the relevant national stakeholders.

Until recently, many research reactors were sited in geographic locations without serious considerations for security. For example, NIRR-1 became operational in 2004 with a HEU core and no HRP considerations. Today, NIRR-1 is undergoing a core conversion from HEU to LEU fuel as well as a pilot HRP programme to mitigate any insider threat situations.

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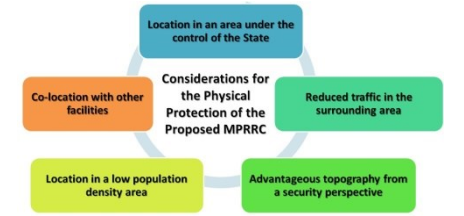
{Considerations for the PPS of the New MPRRC}

The siting of the MPRRC takes into cognisance pertinent geographical features that enhance security of the facility. The siting characteristics considered for the location of the MPRRC include:

- **Location in an area under the control of the State.**
- **Reduced traffic in the surrounding area.**
- **Advantageous topography from a security perspective.**
- **Location in a low population density area.**
- **Co-location with other facilities.**



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{The Site}

Thus, the MPRRC site is about 75 km southwest of Nigeria's capital Abuja; about 30 km from an international airport and can be reached via a major highway. The site area is situated at a slope gently dipping with an inclination of approximately 3% from west to east towards a north-south oriented branch of a small river. The terrain is a sparse forest with isolated trees and shrubs embedded into the grass-land vegetation.

The topography of the site is therefore excellent for the erection of guard towers to enable guards have a 360-degree viewing of the site.

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{The Population} The population density of the surrounding area is low. The population in the area is about 200, and is about 3 km from a nearby small village with a small population. The nearest populated area is about 13 km from the MPRRC site on the northern axis with an estimated population of about 200,000 people.

{Existing Structures} There are a few already existing laboratories and other facilities, including a Gamma Irradiation Facility (GIF) in the neighbourhood of the MPRRC site. Other facilities within the neighbourhood include a building housing the Central Workshop, a Waste Management Facility (WMF), a three-storey building for Nuclear Instrumentation and Nuclear Security Laboratories, some other administrative buildings, research laboratories and residential buildings which are about 500 m away.

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{Countering Potential External Threats}

Possible ways of countering potential external threats to the MPRRC include:

Accessibility Features

- The gently sloped topography of the site is ideal for the erection of guard towers for a 360-degree observatory of the site distant surroundings. 1
- Mounting of electrified wire mesh Inner fence around the MPRRC with an alarmed isolation zone between the outer and inner fences. 2
- Biometric access control to the secluded MPRRC area at the ACB and ACPs 3
- Surveillance CCTV with alarm systems 4
- Deployment of well-trained unarmed guards, armed guards and response forces to the MPRRC area in collaboration with the Office of the National Security Adviser (ONSA) 5

MPRRC COUNTER-THREAT MEASURES

Other Features

- The low populations within the MPRRC site and adjoining areas imply that intruders can easily be distinguished and apprehended 1
- The MPRRC site is close to an international airport, hence there is the possibility of aircrafts overflying the site. There is the need to liaise with relevant authorities to declare "NO FLY ZONE" around the MPRRC site 2
- Armed response organisations are located within reasonable distances to the site that can be brought in when and if the need arises. 3

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{Structure, On-Site Staffing and Security of the Proposed MPRRC}

The proposed MPRRC is organised into four (4) departments: Reactor Operations, Research & Services, Security, and Administration & Finance. The Reactor Operations Department is to be headed by the Reactor Manager while the other departments are to be headed by directors. The head of the MPRRC is the Coordinating Director. The staffing requirements are about 200 personnel. This number includes 7 supervisors for the research and services units and about 30 armed men in the Special Response Team (SRT).

The organization and staffing takes security into account and it includes the access, authority, and knowledge of facility for employees and other vendors or inspectors who would have routine access to areas within the MPRRC's Protected Area (PA). Of the total number of employees and others, about 75% would require authorized access to the PA while 25% would not have any access to the PA.

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{Structure, On-Site Staffing and Security of the MPRRC}

To be employed at the proposed MPRRC, employees must undergo trustworthiness checks while some will be in HRP and be granted a security clearance based on the access required to perform their duties. The following levels of checks are to be conducted in order to grant access to the facility:

a. **Level 1: Identity, education, employment history, and financial history.**

b. **Level 2: Identity, education, employment history, financial history, criminal history, Security and intelligence agency check.**

Some of the supervisors should also be trained in Behavioural Observation Programme (BOP) which qualifies them to detect individual behavioural changes, which, if left unattended, could lead to threats to the safety or security of the facility or its employees.

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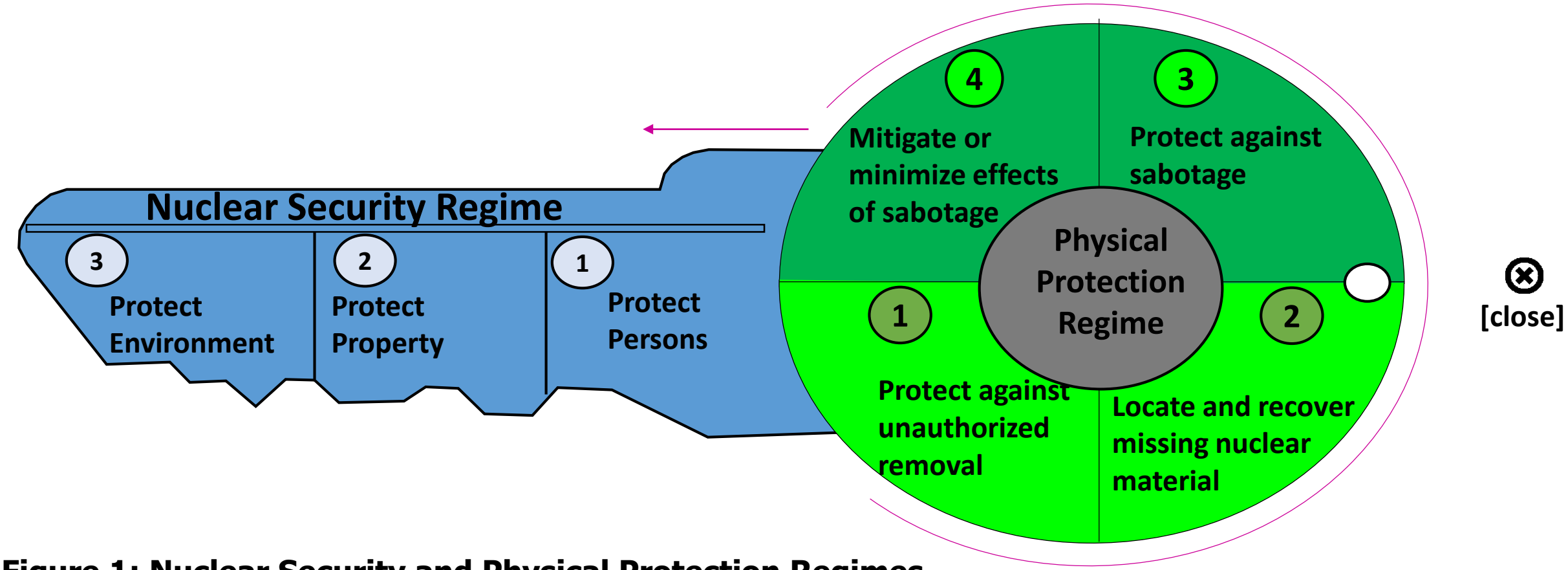
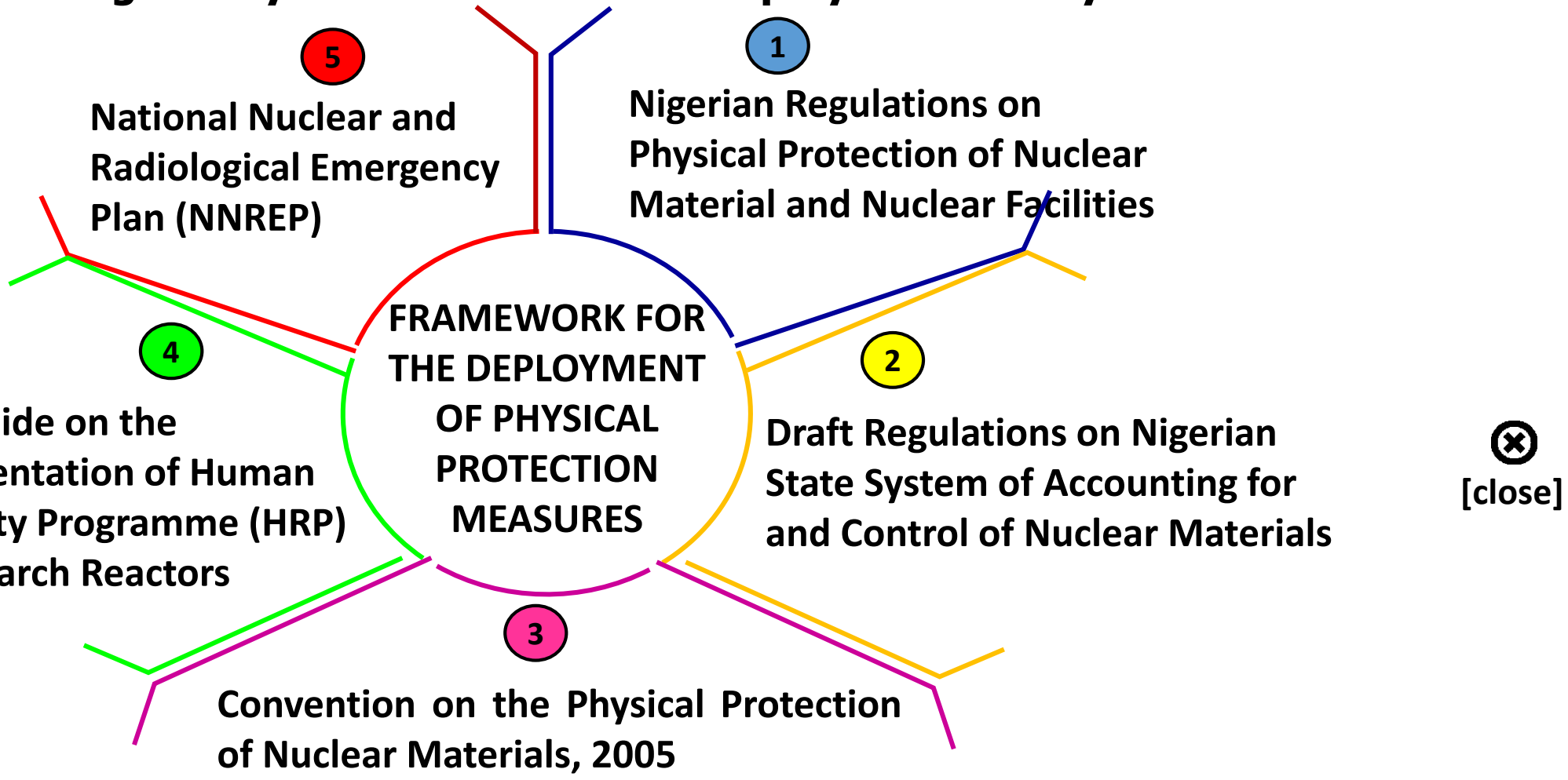


Figure 1: Nuclear Security and Physical Protection Regimes

Legislative and Regulatory Framework for the Deployment of Physical Protection



Physical Protection Enabling Framework

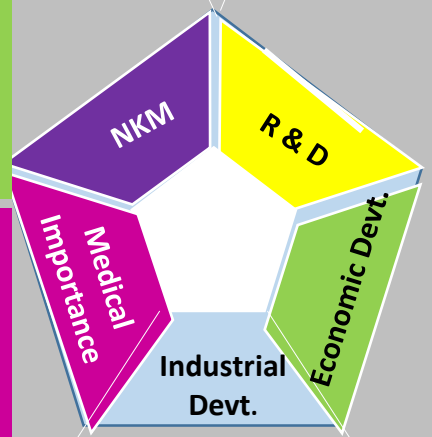
These documents provide proper guidance for the development of the physical protection measures for all nuclear facilities in the country including research reactors.

JUSTIFICATION FOR THE PROPOSED MPRRC

Nigeria, with its vast oil and gas resource is a large consumer of industrial radioactive tracers, which are extensively deployed for well logging and pipeline integrity checks amongst other oil exploration related activities, as well as in agriculture, hydrological surveys and other NDT uses.

Local production of radioisotopes for applications in health, agriculture and industrial sectors of the economy will result in significant savings in foreign currency and will also generate earnings from export of radioisotopes.

Radioisotopes are currently imported into the country. As they are short-lived, some of these medical radioisotopes often expire before getting to their point of use.



The proposed MPRRC will provide scientists and engineers in academia a platform for research in peaceful applications of nuclear technology for socio-economic development.

It is expected that the experience gained in the safe operation of a MPRR would be of advantage to Nigeria in the implementation of the NP programme.

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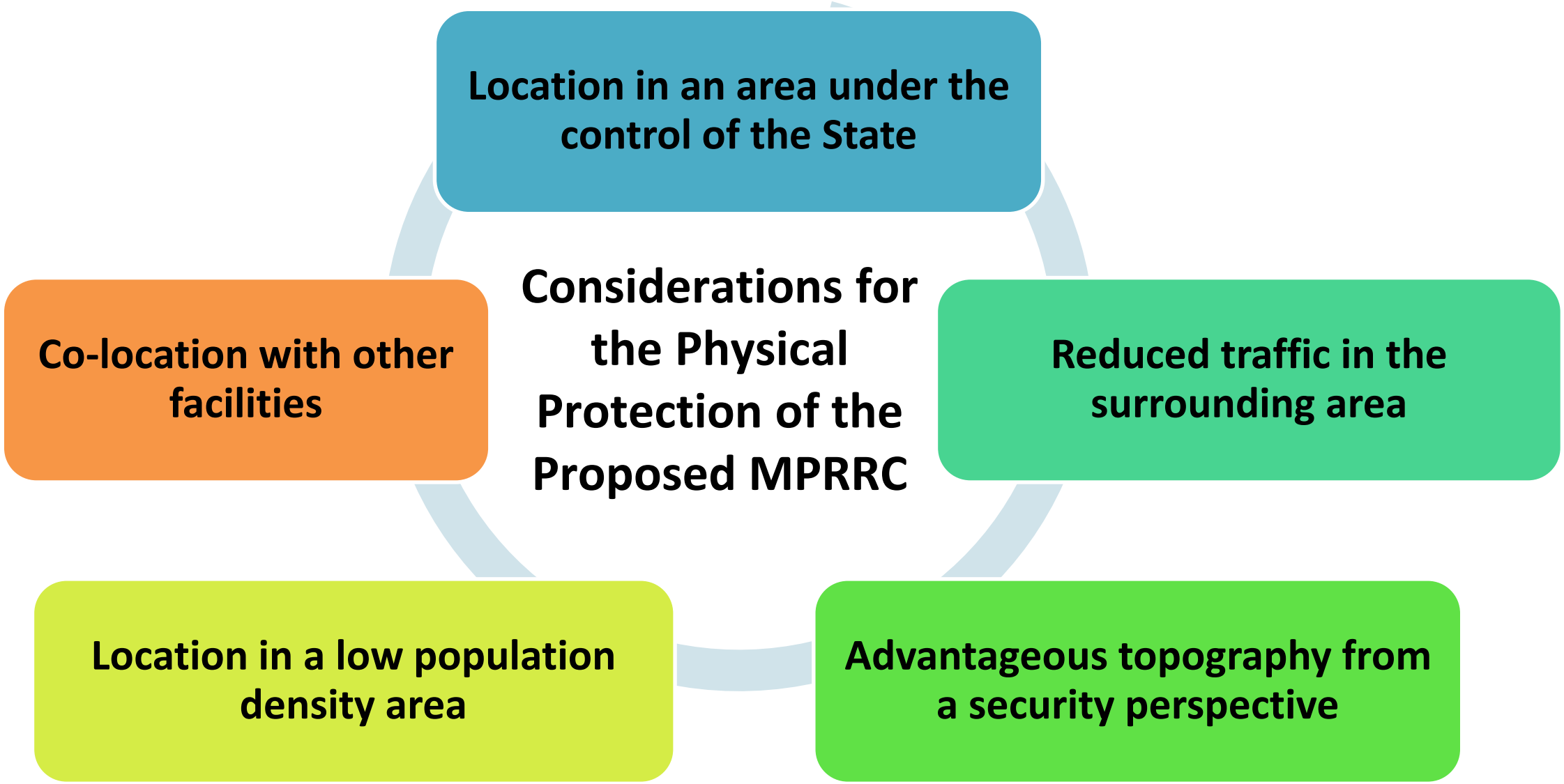
Need for MPRRC

SITING AND SECURITY CONSIDERATIONS FOR THE PROPOSED MPRRC



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Access Road
Medical Centre and Recreational Facilities
Laboratories
Researchers Hostel & Conference Centre
Laboratories
GIF and other offices
Stream – Natural Barrier
Major Highway
Click here to zoom into the MPRRC Site
503 m
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Google Earth

Multi-purpose Laboratories

GIF & Warehouse

WMF

MPRRC Site measures more than 500m X 300m

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On-Site Operations Staff and Security of Proposed MPRRC

Position (Operational Units)	Authorized Access and Cleared Level	Authority/Responsibility	Knowledge
Coordinating Director (Office of the CD)	Administrative Areas, Access to PA requires escort. Level 1	•Overall management of the MPRRC	General knowledge of the operations of the complex but no detailed understanding of each facility.
Health Physic and Environment Unit	Some personnel will have access to Administrative Areas, PA, All Vital Areas, with Level 2 Trustworthiness	•Analyze safety and impacts of proposed changes, develop/review procedure revisions, prepare documents for State regulator • Monitor radiological conditions Not permitted to work on plant equipment	General knowledge of performance and roles of facility systems, but no detailed knowledge of operation of complete facility systems. Specialized knowledge related to their duties, narrow knowledge of facility systems.
Plant Manager (Reactor Manager)	PA, Escorted Access to All Inner Areas[1] and Vital Area, Level 2	•Overall direction but not authorized to direct detailed facility operations •BOP Qualified	General knowledge of plant operations, lacks detailed understanding of facility
Reactor Operations Group	PA, All Vital Areas, Reactor Hall , Level 2	•Detailed direction of all facility activities •Direction obeyed without question in most situations • Some supervisors will be BOP Qualified • Detailed direction of all reactor operations •Perform all material packaging and movements	Extensive, detailed knowledge about all aspects of facility design, layout and operation Specialized knowledge related to their duties, material packaging and movements, narrow knowledge of complete facility systems.
Maintenance Group	PA, All Inner and Vital Areas pertaining to their specialties, Level 2	•Perform activities on specific systems pursuant to work orders and plan of the day •BOP Qualified	General knowledge of plant operations Specialized knowledge related to their duties, narrow knowledge of complete facility systems.
Engineering Group	Administrative Areas, PA, All Inner and Vital Areas pertaining to their specialties, Level 2	•Support plant engineering activities •Perform NM operations and inventories at the direction of Material Balance Area (MBA) custodians	Specialized knowledge related to their duties
Research & Services Department	Administrative Areas, PA, Level 2	•Carry out all R&D activities in their various R&D units	Specialized knowledge related to their R&D activities
Security Department	PA, All Inner and Vital Areas as detailed in standard operating procedures, Level 2	•Monitor alarms and direct responses •Testing and Calibration of Physical Protection Equipment •Routine patrol of PAs and non-radiological areas •Staff access control and other security posts •Perform security analysis activities and review performance and status of specific systems •Maintaining locks and keys	No knowledge of facility systems, but knowledgeable about their specialized plant security systems and security procedures
Admin & Finance Department	Administrative Areas, Access to PA requires escort, Level 1	•Administrative support as necessary •No authority over plant employees	No working knowledge of facility systems Knowledge of assigned duties only
Others (Visiting Researchers/Scientists etc	Escorted access in the PA. Security clearance required	•No authority over plant employee	Knowledge in their fields only

[close]

[1] Inner Area is defined as an area with additional protection measures inside a protected area, where Category I nuclear material is used and/or stored. Vital Area is defined as an area inside a protected area containing equipment, systems or devices, or nuclear material, the sabotage of which could directly or indirectly lead to high radiological consequences.
[2] Level 1: Identity, education, employment history and financial history. Level 2: Identity, education, employment history, financial history, criminal history, Security and intelligence agency check.