*KNS CONFERENCE PRESENTATION*

# Strengthening the Regulatory Processes and Documentation Across the Lifecycle of Nigeria's Research Reactor

## *A Proposal for Formalising Regulatory Oversight Functions in Response to the 2017 IAEA IRRS Recommendation 7*

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# Table of Contents


| | | |
|---|---|---|
| 01 | Background & Problem | 3 |
| 02 | Regulatory Framework | 11 |
| 03 | Methodology & Results | 15 |
| 04 | Proposed Framework | 20 |
| 05 | Recommendation & Conclusion | 24 |
| | References | 27 |

# 01

# Background & Problem

# Overview of Research Reactors

### Purpose

Research reactors are designed for research, education, training, and radioisotope production; not electricity generation.

### A Nation's First Step

They often serve as a country's first nuclear facility; supporting the development of regulatory and technical capacity.

# Nigeria's Research Reactor (NIRR-1)

- Nigeria operates one research reactor - the Nigerian Research Reactor 1 (NIRR-1), commissioned in 2004.
- The NIRR-1 is a 34-kW tank-in-pool Miniature Neutron Source Reactor (MNSR) located at the Centre for Energy Research and Training (CERT), Ahmadu Bello University, Zaria, Kaduna State.
- The operation of the NIRR-1 is regulated by the Nigerian Nuclear Regulatory Authority (NNRA).

**2004**

Commissioned

**34 kW**

Nominal Power

**MNSR**

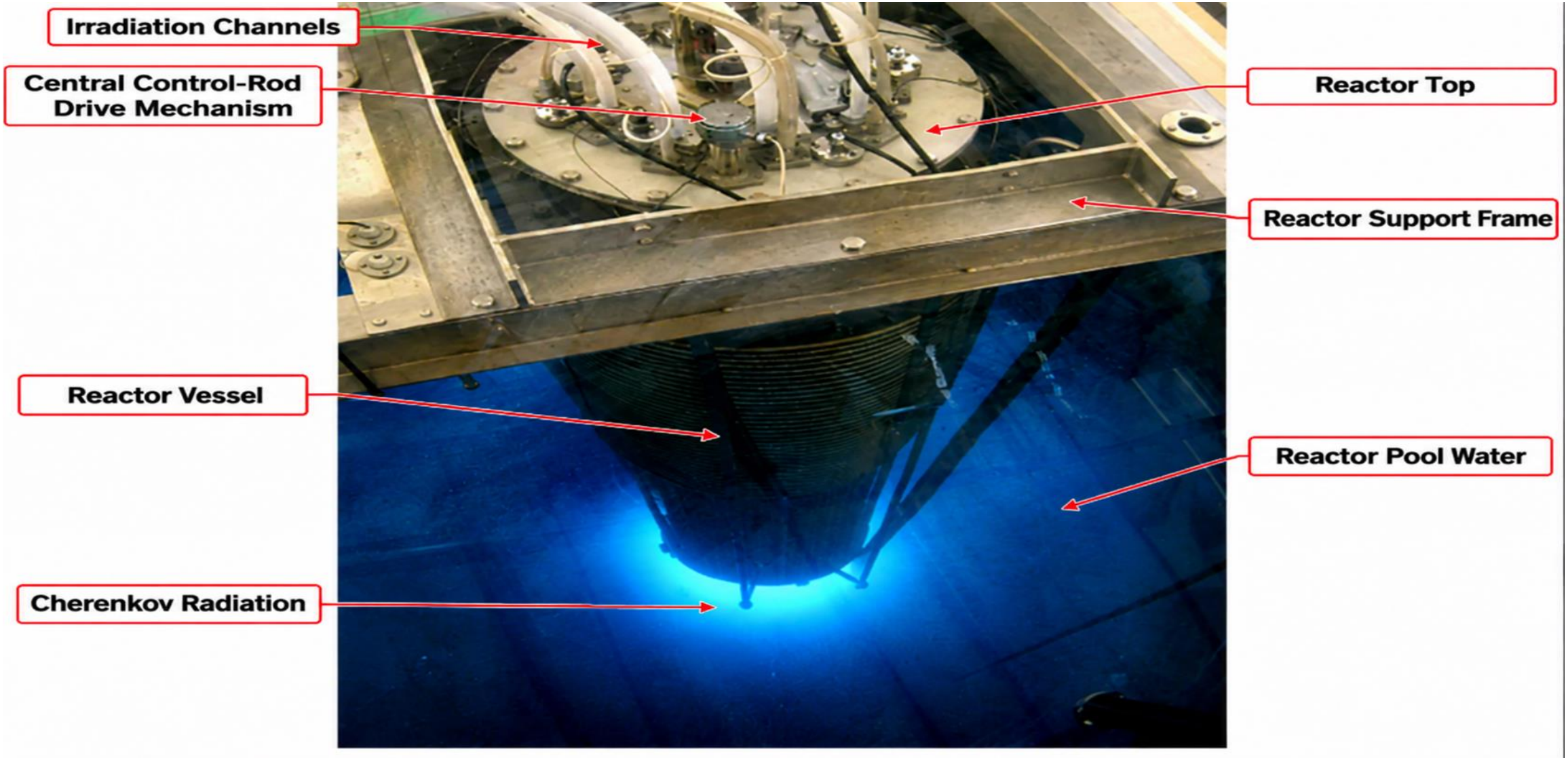
Reactor Type


Zaria
KADUNA
Abuja
NIGERIA

# Technical Description of the NIRR-1

| Parameter | Specification |
|---|---|
| **Reactor Type** | Miniature Neutron Source Reactor (Tank in Pool) |
| **First Criticality** | Feb. 03, 2004 |
| **Operational Licence** | June 01, 2004 |
| **HEU to LEU Conversion** | November 2018, second criticality |
| **Fuel Enrichment** | From 90% to 13% |
| **Nominal Flux / Power** | $1.0 \times 10^{12}$ ncm$^{-2}$ s$^{-1}$ / 34 kW |
| **Fuel Rods** | 347 installed and 3 extra rods |
| **No. of Control Rods / Material** | 1 / Cadmium |
| **Total U-235 Fuel / Fuel Type** | 1 kg / Uranium-aluminum alloy |
| **Moderator / Coolant** | Light Water |
| **Reflector** | Metallic Beryllium |
| **Main Uses** | NAA, training/teaching, research and limited isotope production |

# The NIRR-1

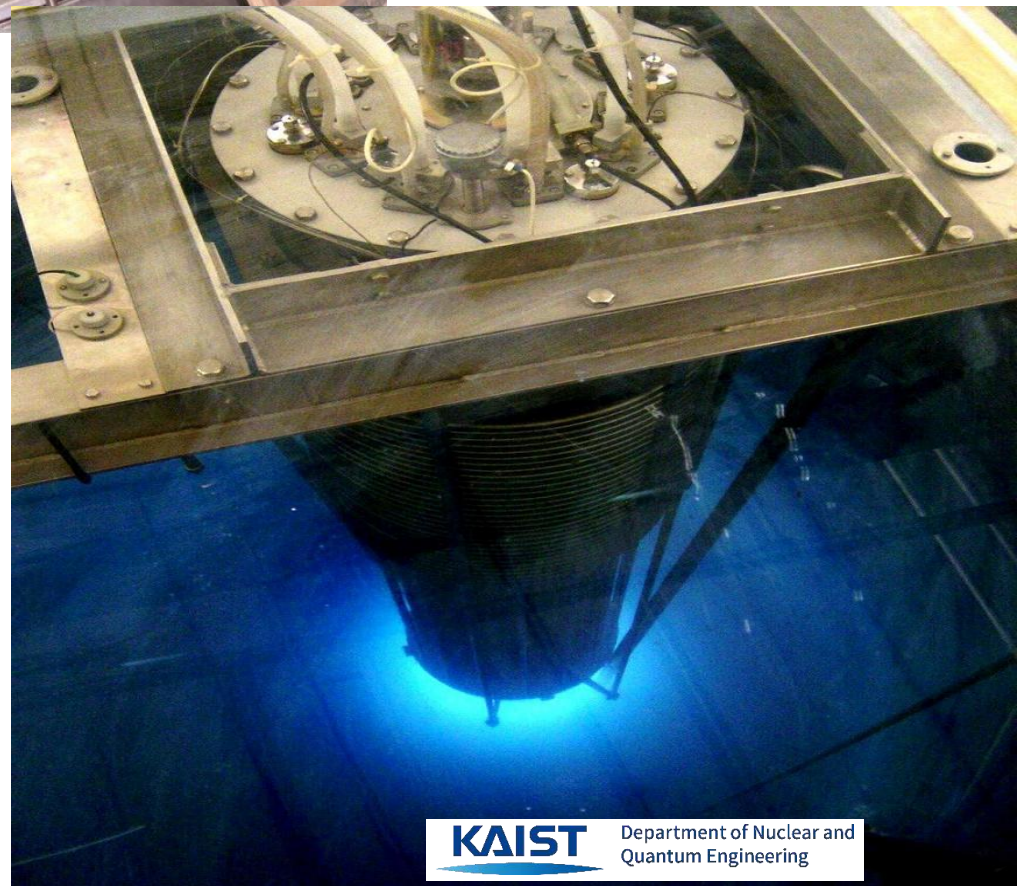

Irradiation Channels
Central Control-Rod Drive Mechanism
Reactor Top
Reactor Support Frame
Reactor Vessel
Reactor Pool Water
Cherenkov Radiation

# The NIRR-1 Facility









*NIRR-1 reactor tank assembly, protective frame, pool and core assembly.*

# IAEA IRRS Mission & Recommendation 7

- The International Regulatory Review Service (IRRS) is an IAEA peer review service to help member states strengthen their national frameworks for nuclear and radiation safety.
- The 2017 IRRS Mission to Nigeria identified gaps in formal regulatory processes and procedures.
- Recommendation 7 calls for formalising the authorization, review, assessment, inspection and enforcement processes based on defined policies and criteria.

**RECOMMENDATION 7**

***"NNRA should develop formal processes and procedures for authorization, review and assessment, inspection and enforcement, as necessary, that are based on specified policies, principles and associated criteria."***




*2017 IAEA IRRS Mission Report to the Federal Republic of Nigeria.*

### 3.6. STABILITY AND CONSISTENCY OF REGULATORY CONTROL

NNRA has established regulatory processes for authorization, review and assessment, inspection and enforcement. NNRA has identified some policies, criteria and procedures that are used in the decision-making process and are meant to ensure stability and consistency of regulatory control. However, not all regulatory activities have documented procedures and some documents are not issued but are in draft stage.

| RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES | |
|---|---|
| **Observation:** NNRA has established regulatory processes for authorization, review and assessment, inspection and enforcement, however not all regulatory activities have documented procedures developed and implemented to ensure consistency in the decision-making process. NNRA does not have a licensing process and acceptance criteria related to the safety of the research reactor to support its decision-making process. | |
| (1) | **BASIS: GSR Part 1 (Rev. 1) Requirement 22 para. 4.26 states that** *"The regulatory process shall be a formal process that is based on specified policies, principles and associated criteria, and that follows specified procedures as established in the management system. The process shall ensure the stability and consistency of regulatory control and shall prevent subjectivity in decision making by individual staff members of the regulatory body. The regulatory body shall be able to justify its decisions if they are challenged. In connection with its reviews and assessments and its inspections, the regulatory body shall inform applicants of the objectives, principles and associated criteria for safety on which its requirements, judgements and decisions are based."* |
| (2) | **BASIS: SSR-3 Requirement 1 para. 3.12 states that** *"Each State shall develop its own approach to acceptance criteria depending upon its particular legal and regulatory infrastructure. Acceptance criteria based on principles for safe design and operation shall be made available to the operating organizations."* |
| R7 | **Recommendation: NNRA should develop formal processes and procedures for authorization, review and assessment, inspection and enforcement, as necessary, that are based on specified policies, principles and associated criteria.** |

# Aim of the Research



## AIM

To propose a framework for formalising regulatory processes and documentation across the lifecycle of Nigeria's research reactor in response to the 2017 IAEA IRRS Recommendation 7.

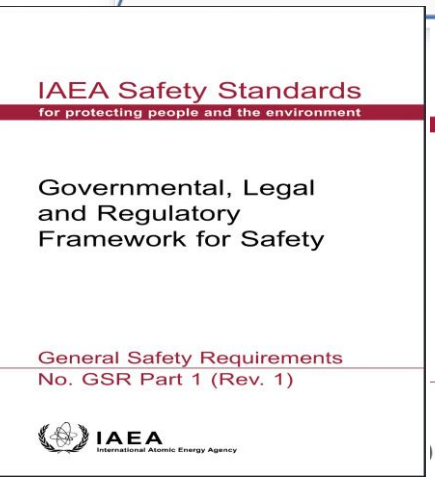
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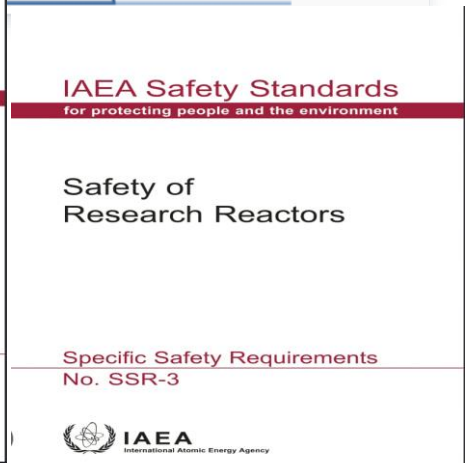
# Regulatory Framework

# Regulatory Frameworks: IAEA, Korea & Nigeria

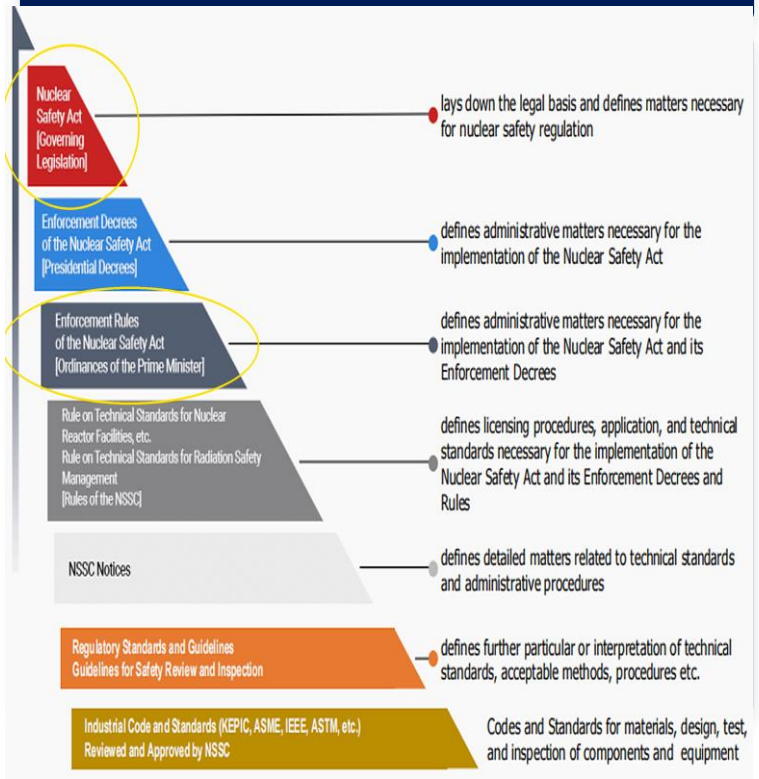
## IAEA Safety Standards



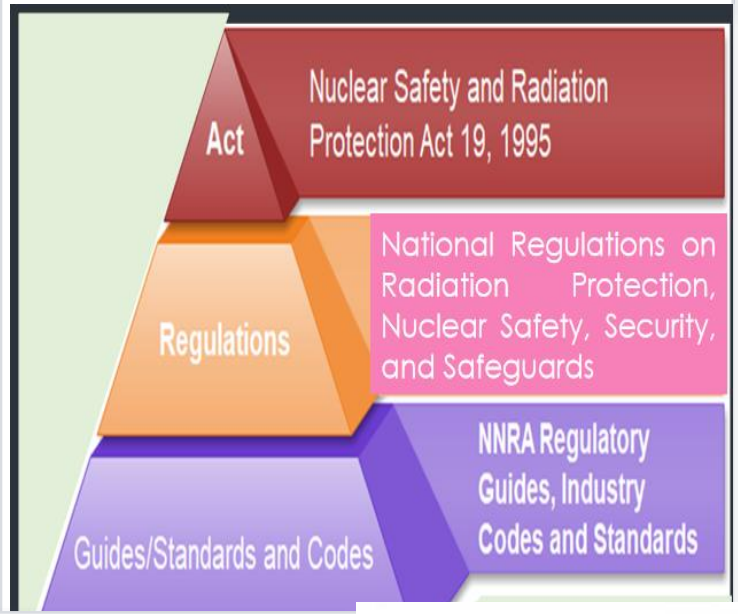



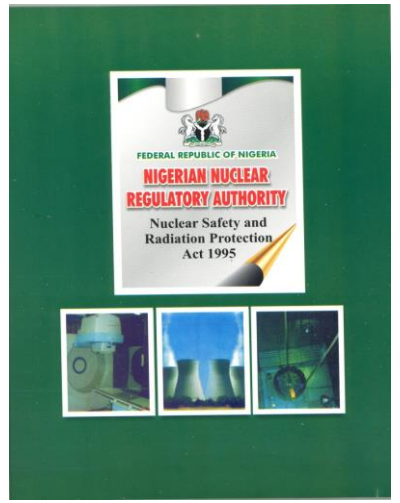

## South Korea (NSSC)

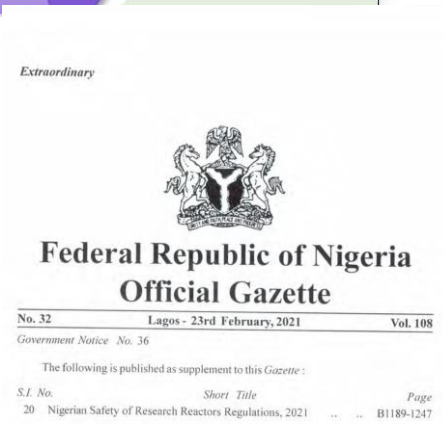



*Nuclear Safety Act → Enforcement Rules*

## Nigeria (NNRA)



# Oversight Functions

### Authorization

Granting approvals at the applicable lifecycle stages on the basis of fulfilling regulatory requirements, in form of permits, certificate, licence, etc.

### Review and Assessment

Reviewing safety documentation (e.g., the SAR) to verify safety throughout the facility lifecycle.

### Inspection

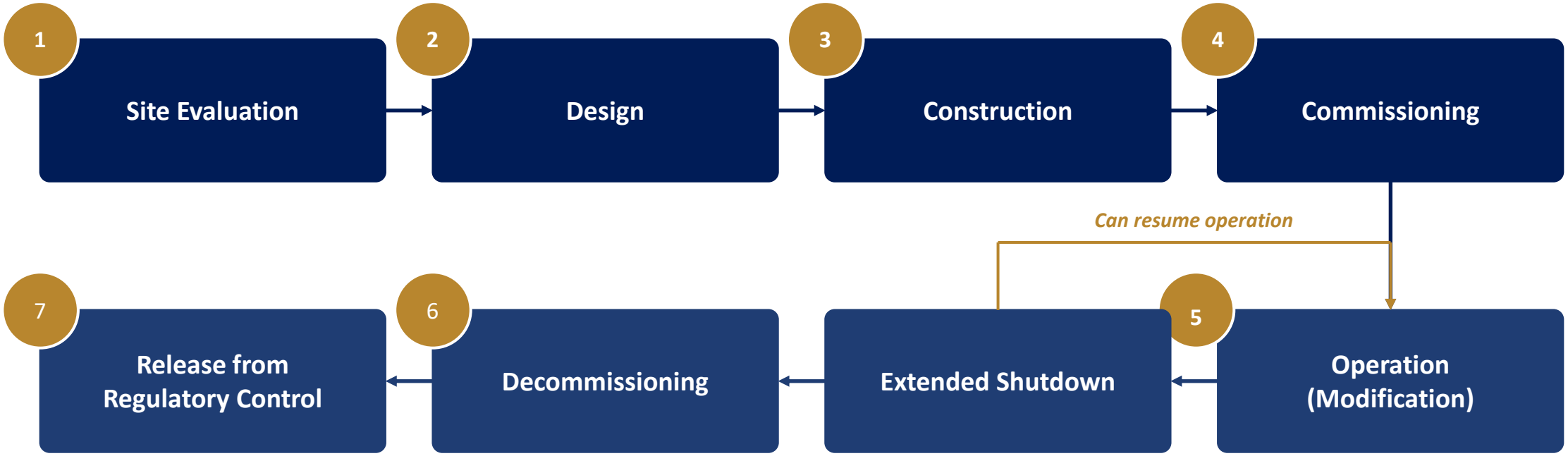
Physically visiting and examining the facility to verify compliance with licence conditions, OLCs and applicable codes/standards.



### Enforcement

Corrective action, suspension or revocation of authorization where deviations occur.

# Research Reactor Lifecycle Stages



# 03

# Methodology & Results

# Basis of Comparison

- IAEA Safety Standards (SSR-3 & related guidance): international benchmark for research reactor safety and regulatory oversight.
- South Korean Regulatory Framework: a practical example of implementing IAEA requirements within a mature research reactor regulatory system.
- Purpose: assess the NNRA framework against these benchmarks to validate the IRRS recommendation, and develop a lifecycle-based regulatory documentation framework to address the gaps and strengthen research reactor regulations in Nigeria.



# Result of Comparison

*Based on comparison of the SSR-3, the Korean Nuclear Safety Act and Enforcement Regulations, and the Nigerian Safety of Research Reactors Regulations 2021, the following was deduced about the NNRA framework:*

| Comparison Area | NNRA Status |
|---|---|
| Lifecycle and Regulatory process coverage | Met |
| Lifecycle documentation | Gap |
| Regulatory Process Flow | Gap |
| Authorization | Gap |
| Review and Assessment | Gap |
| Inspection | Gap |
| Enforcement | Gap |

# Result of Comparison

| | | |
|---|---|---|
| **Lifecycle workflow** | **NNRA GAP**<br>Requirements dispersed across Parts IV–VIII. | **KOREAN PRACTICE**<br>Documentation structured by authorisation application. |
| **Lifecycle authorisation** | **NNRA GAP**<br>Generic authorisation; no stage-specific instruments (Reg. 4(3)). | **KOREAN PRACTICE**<br>Construction permit, operating licence, change permit and decommissioning approval. |
| **Inspection gating** | **NNRA GAP**<br>Inspection power general; explicit mainly at operation (Reg. 6). | **KOREAN PRACTICE**<br>Inspection linked to most lifecycle decision points (Arts. 16, 22, 28(6)). |

**Three of the identified gap areas are compared below, showing how Korean regulatory requirements and practical experience address each gap.**

## Life-Cycle Regulatory Comparison: Nigeria, Korea and IAEA SSR-3

| Lifecycle Stage | Nigeria - Safety of Research Reactors Regulations, 2021 | Korea - Nuclear Safety Act / Enforcement Rules | IAEA - SSR-3 |
|---|---|---|---|
| 1. Site evaluation | Explicit: Reg. 4(2)(a), Part IV, Regs 16–17. NNRA reviews/assesses SAR; Docs: site evaluation report forms first SAR part; hazard/seismological/geotechnical records | Not explicitly identified as a separate stage. | Explicit 3.4(a), Sec. 5, paras 5.1–5.12. Independent regulatory review required before design. Docs: Site evaluation forms part of SAR. |
| 2. Design | Explicit: Merged with construction: Reg. 4(2)(b), Part V, Regs 18–65. NNRA reviews/verifies SAR and approves design. Docs: more detailed SAR, acceptance criteria, design basis, codes/standards (Regs 8(3)–(4), 46). | Not explicitly identified as a separate stage. | Explicit 3.4(b), Sec. 6, Reqs 7–66. Design justification/safety assessment reviewed before construction; Docs: SAR and decommissioning plan required (Reqs 1, 5, 6, 41, 89). |
| 3. Construction | Merged with design. | Explicit: Art. 30; ER Art. 25. Commission reviews PSAR/construction permit, inspects, and may order corrective action or suspend/cancel permit (Arts 16, 32, 34). Docs: PSAR, REIA, QAP, decommissioning plan; site records and non-conformity reports required (Art. 30(2); Arts 15–18 via 34). | Explicit: 3.4(c), Req. 14. Construction starts only after design verification and regulatory authorization; Docs: as-built/design comparison and non-conformance records required. |
| 4. Commissioning | Explicit: Regs 83–85. NNRA reviews commissioning programme and participates in staged tests A/B/C; programme, procedures, records and reports required. | Not explicitly identified as a separate stage. | Explicit: 3.4(d), Req. 73. Regulatory review of commissioning programme and involvement in staged tests; test procedures/reports required (paras 7.49–7.55). |
| 5. Operation | Explicit: Reg. 4(2)(d), Parts VI–VII. Inspection, surveillance, enforcement and review; Docs: updated SAR, OLCs, operating procedures, PSR reports, emergency, ageing, RP and waste programmes required (Regs 66, 74, 82, 86, 90, 92–94, 98). | Explicit: Arts 20, 30-2; ER Art. 16. Pre-licence and periodic inspections; PSR review; corrective measures/suspension/cancellation possible (Arts 22–23, 32). Docs: F-SAR, operation guidelines, QA plan and PSR reports required (Art 30-2(2)). | Explicit: 3.4(e), Sec. 7, Reqs 67–88. Compliance with OLCs, modification review, operating experience/ageing management; updated SAR, OLCs, procedures and records required (Reqs 1, 71, 74, 82, 83). |
| 6. Modification | Within operation. Modification/utilization controlled under Reg. 92. | Within operation: Arts 30(1), 30-2(1); ER Arts 12, 26. Major changes use comparative pre-/post-change review; minor changes reported on prescribed form. | Within operation; utilization/modification covered by Req. 83. |
| 7. Extended shutdown | Process within operation: Reg. 99. NNRA notification and authorization to resume after tests meet predetermined conditions; shutdown arrangements and restart test records required. | Process within operation: Termed as permanent shutdown. Commission approval required for licence alteration. Arts 21(2), 26(5). | Process within operation: Req. 87. Operating organization maintains arrangements; oversight continues through licence conditions; OLC records required. |
| 8. Decommissioning | Explicit: Reg. 4(2)(e), Part VIII, Reg. 101. Plan reviewed/approved at conception and initial authorization; financial provision required before operation; plan updated throughout life and detailed before activities. | Explicit: Art. 28 (via Art. 34), ER Art. 22/30. Commission approves status and completion, inspects, terminates licence and may impose site-reuse conditions; Docs: completion/status reports required. | Explicit: 3.4(f), Req. 89. Plan approved before decommissioning; prepared at design and updated throughout life (paras 8.1–8.2). |
| 9. Release from regulatory control | Explicit: Reg. 4(2)(f) no separate procedure beyond decommissioning provisions; no separate documentation specified. | Not named as a separate stage, but functionally achieved after verified decommissioning completion; written licence termination follows (Art. 28(8)–(9)). | Explicit: 3.4(g); release follows completion of the lifecycle process. |

Lifecycle and process coverage  Documentation flow  Authorization  Inspection

# 04

# Proposed Framework (Regulatory Guide)

# Proposed Regulatory Process and Documentation Concept

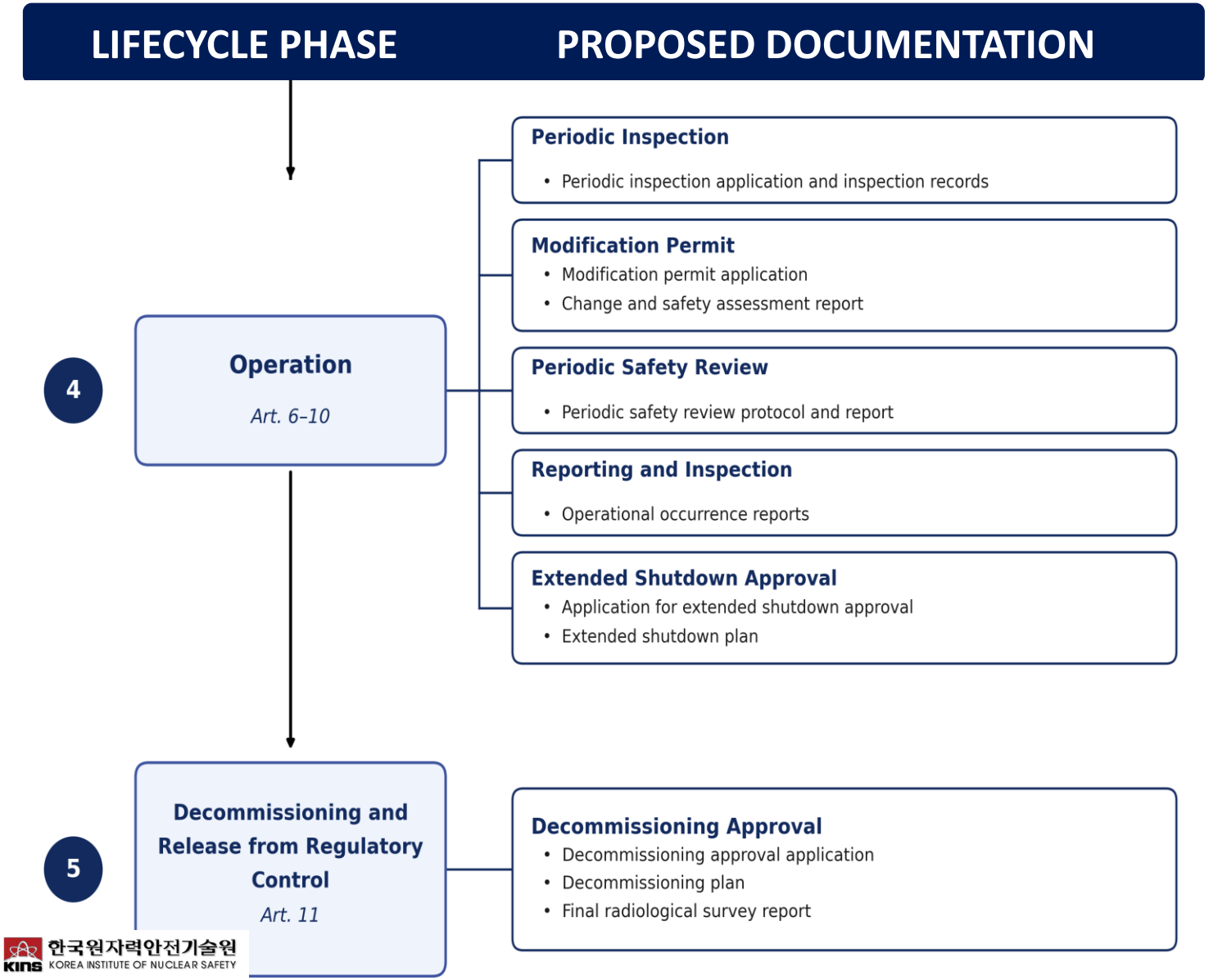
| LIFECYCLE PHASE | PROPOSED DOCUMENTATION |
|---|---|
| 1 **Site Evaluation** *Art. 1* | **Site Pre-approval**<br>• Application for site pre-approval<br>• Radiological and environmental impact assessment (REIA) & Site Quality Assurance Plan (QAP)<br>• Site survey report |
| 2 **Design and Construction** *Art. 2-3* | **Construction Permit**<br>• Construction permit application<br>• PSAR, QAP & RPP<br>• Construction schedule and progress plan<br>• Radiation protection plan and other required documents |
| | **Pre-service Inspection**<br>• Pre-service inspection application<br>• QA inspection records<br>• Fabrication, welding and NDT records |
| 3 **Commissioning** *Art. 4-5* | **Commissioning Inspection**<br>• Commissioning inspection application<br>• Commissioning programme and test report |
| | **Operating Licence**<br>• Operating licence application<br>• Radiological and environmental impact assessment, Radiation protection plan & Final safety analysis report (REIA, RPP & FSAR)<br>• Operating procedures<br>• Technical specifications |

## STAGES 1–3 OF 5

Each lifecycle phase is paired with its own named regulatory process and a defined set of supporting documentation, closing the gap identified as compared against Korean practice, where each stage carries a distinct, reviewable instrument.

*Continued on the next slide: Operation & Decommissioning →*

# Proposed Regulatory Process and Documentation Concept (cont'd)




## STAGES 4–5 OF 5

The Operation lifecycle phase is the most heavily regulated phase of the research reactor lifecycle, 5 regulatory processes span that stage alone

*Decommissioning closes the lifecycle with a formal decommissioning approval*

# An Example Using Article 2: Construction Permit

1 | **2** | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11

**Phase II – Design and Construction**

**Authorisation**

PROPOSED PROCESS AND REQUIREMENTS

- Permit proposed as a requirement before building reactor facilities; conditions could attach where unavoidable.
- Fraud or unmet criteria would expose the permit to revocation, suspension or a corrective-action order.
- **2-1, 2-2** 30-day notification period; total processing period of 24 months, with the same exclusions as 1-2.
- **2-3, 2-4** Review report prepared, then submitted for internal technical deliberation before the permit is granted.
- **2-5** Authorization is granted (Construction Permit)
- **2-13** Change control: post-submission changes need the Authority's permission and resubmission of affected documents.

**30 days**
notification / supplement request (2-1)

**24 months**
total processing period (2-2)

REQUIRED DOCUMENTATION **2-6 - 2-10**

- Construction REIA Report (2.2)
- Construction QA Plan (2.3)
- Construction Radiological Emergency Plan (2.4)
- Preliminary Safety Analysis Report (2.5)
- Construction Technical Capability Statement (2.6)
- Statement of Purpose of Use (2-11)

PROPOSED OMISSION (2-12), IF RECOGNISED

| REIA | QA Plan | Rad. Emerg. Plan |
|---|---|---|
| < 100 kW | < 10 kW | < 2 MW |

# 05

# Recommendations & Conclusion

# Recommendations for Identified Gaps Based on Developed Proposal

*How the proposed framework closes each identified gap:*

| | | |
|---|---|---|
| 1 | **No integrated lifecycle regulatory workflow** | **PROPOSED FRAMEWORK RESPONSE**<br>Consolidate documentation by lifecycle-stages. |
| 2 | **Lifecycle authorisations not stage-specific** | **PROPOSED FRAMEWORK RESPONSE**<br>Name a distinct authorisation instrument at each applicable stage, e.g., pre site approval, construction permit, decommissioning approval, etc. |
| 3 | **Inspection not gated to lifecycle transitions** | **PROPOSED FRAMEWORK RESPONSE**<br>Attach inspection as an explicit precondition at the applicable transitions, e.g., pre-service inspection, commissioning inspection, in-service inspection, etc. |

**FUTURE WORK**

- Apply this guide to actual NIRR-1 licensing and inspection records.
- Engage NNRA personnel to validate its practical effectiveness.

# Conclusion

Gaps in the NNRA's formal regulatory processes, identified in relation to the 2017 IAEA IRRS Recommendation 7, are addressed by a proposed lifecycle-based regulatory documentation framework, informed by South Korean practice and aligned with IAEA Safety Standards, which strengthens consistency, transparency and regulatory oversight.

## How the four oversight functions are represented across the 11 articles and 5 lifecycle stages

| Lifecycle stage (articles) | Authorization | Review and Assessment | Inspection | Enforcement |
|---|---|---|---|---|
| **1 Site Evaluation (Art. 1)** | Site Pre-Approval (Art. 1) | Review schedule; 12-month processing (Art. 1) | | |
| **2 Design and Construction (Arts. 2–3)** | Construction Permit (Art. 2) | Review report and internal deliberation before grant (Art. 2) | Pre-Service and QA Inspections (Art. 3) | Revocation, suspension or corrective action (Art. 2); corrective action (Art. 3) |
| **3 Commissioning (Arts. 4–5)** | Operating Licence (Art. 5) | Acceptance-criteria check (Art. 4); review report (Art. 5) | Commissioning Inspection (Art. 4) | Revocation, suspension or corrective action (Art. 5) |
| **4 Operation (Arts. 6–10)** | Modification Permit (Art. 7); Extended Shutdown Approval (Art. 10) | Periodic Safety Review (Art. 8) | In-service (Art. 6); reactive (Art. 9); during shutdown (Art. 10) | Revocation, suspension or corrective action (Arts. 6, 9); corrective-action order (Arts. 8, 10) |
| **5 Decommissioning and Release (Art. 11)** | Decommissioning Approval (Art. 11) | Decommissioning Plan (Art. 11) | Inspection during decommissioning (Art. 11) | Corrective-action order (Art. 11) |

# Key References


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*Thank you for your time and attention*

**Questions & Comments**