

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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1. Introduction

Research reactors support education and training, neutron-based research, and radioisotope production, while providing developing nuclear States with early regulatory experience. Nigeria operates a single research reactor, the Nigeria Research Reactor-1 (NIRR-1), a 34-kW miniature neutron source reactor regulated by the Nigerian Nuclear Regulatory Authority (NNRA), whose oversight is expected to align with IAEA safety standards.

The 2017 IAEA Integrated Regulatory Review Service (IRRS) Mission to Nigeria found that, although NNRA had established the legal and institutional basis for nuclear regulation, its processes for authorisation, review and assessment, inspection, and enforcement were not fully formalised around defined policies and criteria (Recommendation 7) [3]. While applicable regulatory instruments exist, they do not provide a coherent lifecycle-based framework linking these oversight functions to the documentation required at each stage of the NIRR-1 lifecycle. This paper addresses that gap by benchmarking NNRA's Safety of Research Reactors Regulations, 2021 [4], against IAEA Safety Requirements SSR-3 [2] and the Republic of Korea's Nuclear Safety Act [5] and Enforcement Regulations (ER). A lifecycle-based regulatory documentation framework to operationalise Recommendation 7 while complementing existing regulations was proposed.

2. Method

The study applies a qualitative documentary research design using comparative content analysis, treating legislation, regulations, IAEA safety standards, and the 2017 IRRS mission report as primary evidence. Four reference frameworks were analysed: Nigeria's Safety of Research Reactors Regulations, 2021 [4]; the Republic of Korea's Nuclear Safety Act [5] and its Enforcement Regulations; and the IAEA Research Reactor Specific Safety Requirements SSR-3 [2], which supplied the lifecycle coding frame. The Republic of

Korea's regulations were used as an illustrative comparator because they provide an established regulatory framework for research reactors, offering practical examples of lifecycle-based regulatory documentation while SSR-3 remained the primary normative benchmark for the analysis. SSR-3 structures regulatory oversight around lifecycle stages: site evaluation, design, construction, commissioning, operation, modification, extended shutdown, decommissioning, and release from regulatory control, each linked to the oversight functions of authorisation, review and assessment, inspection, and enforcement [1, 2].

Data collection proceeded through identification of primary instruments, screening for relevance to a lifecycle stage and oversight function, and organisation into a lifecycle-by-function matrix. Each provision was then coded for the lifecycle stage it addresses, the oversight function it represents, and the specific documentation it requires. Provisions were extracted independently for each framework before comparison, and every NNRA and NSSC provision was mapped against its SSR-3 counterpart; the absence of a corresponding provision was recorded as an explicit gap rather than left unaddressed. South Korean practice was treated throughout as an illustrative comparator rather than a second normative benchmark, with departures from SSR-3 explicitly flagged rather than adopted uncritically. SSR-3 was chosen as the coding frame because it is an internationally negotiated standard developed by neither national regulator under comparison, limiting the risk that the analysis favours one jurisdiction over the other. Mapping was documented at the level of individual provisions, allowing the classification of any requirement to be retraced and independently verified. Gaps identified in NNRA's documented requirements, together with SSR-3 requirements and workable NSSC provisions, were then synthesised into a proposed lifecycle-based regulatory documentation framework.

3. Results and Discussion

NNRA's Safety of Research Reactors Regulations, 2021 recognises all major SSR-3 lifecycle stages and is broadly consistent with SSR-3 in technical safety substance. Site evaluation, commissioning, operation, extended shutdown and decommissioning are explicitly recognised as distinct stages with defined regulatory processes and documentation. Design and construction are merged into a single stage, and modification is folded into the operation stage. However, seven documentation and procedural gaps were identified, all concentrated on how the regulatory process is organised rather than on the safety objectives themselves. Collectively, these gaps reduce the transparency, traceability, and consistency of regulatory decision-making throughout the reactor lifecycle. Table I summarises the documentation and procedural gaps identified in the Nigerian regulations and the corresponding regulatory practices adopted in the Republic of Korea.

Gap Areas	NNRA Position	Korean Practice
Lifecycle authorisation	Generic authorisation; no stage-specific instruments (Reg. 4(3)).	Construction permit, operating licence, change permit and decommissioning approval.(Art 30(2)); 28(3))
Inspection gating	Inspection power general; explicit mainly at operation (Reg. 6).	Inspection linked to most lifecycle decision points (Arts. 16, 22, 28(6)).
Lifecycle workflow	Requirements dispersed across Parts IV–VIII.	Documentation structured by authorisation application. (Art. 30(2); 30-2(2))
SAR differentiation	Single evolving SAR across stages (Regs. 8, 13, 16).	Preliminary SAR and Final SAR as formal reviewable documents (ER Art. 25).
Design/ construction documents	No distinct stage-specific documents beyond SAR. (Reg. 8(3)-(4), 13(3))	Preliminary SAR, radiological impact assessment, construction QA and decommissioning plans (Art. 30(2))
Modification tiering	“Significant”/ “major” effects undefined; no documentation tiers (Reg. 4(3)).	Change permit for major modifications; minor-change report for lesser changes. (ER form 16 & 4)
Release from regulatory control	No independent release process beyond decommissioning provisions.	Licence termination through written notice (Art. 28(8)–(9)).

Table I: Identified documentation and procedural gaps compared with korean regulatory practices

These distinctions are largely Korean drafting choices rather than SSR-3 mandates, and the Korean framework itself departs from the SSR-3 lifecycle structure. For example, by folding site evaluation and design into the construction-permit process (Art. 30(2)) and by treating extended shutdown as a form of licence alteration (Arts. 21(2), 26(5)) rather than a dedicated stage. Korean practice was therefore used to inform, not substitute for, recommendations anchored to the complete SSR-3 lifecycle model.

4. Proposed lifecycle-based regulatory framework

Building on this analysis, a lifecycle-based regulatory documentation framework of eleven complementary articles that strengthen NNRA's existing regulatory processes and documentation requirements rather than a replacement of the current Regulations was proposed. These articles are organised across five phases: site evaluation, design and construction, commissioning, operation, and decommissioning and release from regulatory control. Each phase specifies the applicable authorisation, its processing requirements, and the supporting documentation set, cross-referenced to the existing Regulations. The framework operationalises Recommendation 7 directly: authorisation is formalised through pre-approval, permit, and licensing, gated by defined document sets; review and assessment are strengthened through prescribed evaluation reports and processing periods; inspection is formalised through pre-service, commissioning, periodic, and decommissioning inspections with defined scope and timing; and enforcement is addressed through reporting obligations and corrective-action provisions attached to every stage. The proposal concepts are summarized in Figure 1 below.

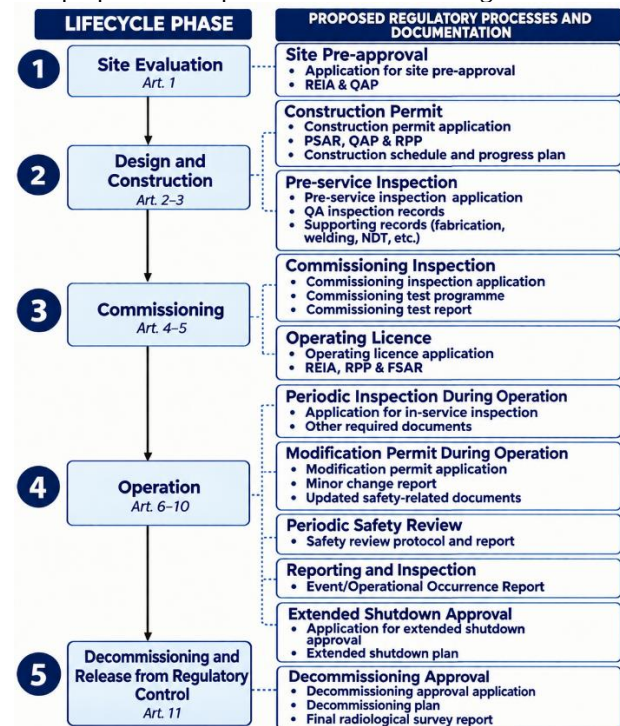


Fig. 1. Proposed lifecycle-based regulatory processes with their documentation

Based on the proposed lifecycle-based regulatory framework, the identified gaps in Nigeria's existing regulatory processes and documentation are addressed through the proposed regulatory processes and associated documentation requirements, as summarised in Table 2 below.

No.	Identified Gap	Recommended Response
1	Lifecycle authorisations not stage-specific	Distinct authorisation instrument at each applicable stage
2	Inspection not gated to lifecycle transitions	Inspection as an explicit precondition at the applicable transitions
3	No integrated lifecycle regulatory workflow	Consolidate documentation by lifecycle-stage authorisation
4	SAR variants not differentiated	Specify Preliminary and Final SAR at defined licensing stages
5	No distinct design/construction documentation	Add stage-specific QA plan, REIA and emergency plan
6	Major/minor modifications undifferentiated	Adopt a two-track change-permit / minor-change report system
7	Limited process for release from regulatory control	Issue a formal decommissioning-completion / termination notice

Table 2: Recommended response to the identified gaps from the developed proposal

5. Conclusion

Nigeria's regulatory framework for NIRR-1 is technically sound but does not yet organise its documentation and oversight activities consistently across every lifecycle stage, consistent with the finding underlying IRRS Recommendation 7. The eleven-article, five-phase lifecycle-based regulatory documentation framework proposed here directly operationalises the recommendation without displacing existing regulations, improving the consistency, transparency, and traceability of NNRA's oversight functions. As a documented, stage-by-stage roadmap rather than new legislation, it offers a practical and scalable model for strengthening research reactor regulation in Nigeria and for future Nigerian nuclear facilities. Future work should apply the framework to actual NIRR-1 licensing and inspection practice and engage NNRA personnel to verify its practical effectiveness.

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