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Enhancing Safety and Security of NORM Transportation across Africa's Extractive Industries: An Integrated Framework for Regulatory Harmonization and Risk Management

The management and transport of Naturally Occurring Radioactive Material (NORM) within Africa's rapidly expanding extractive sector presents critical challenges in radiological safety and nuclear security governance. Despite the establishment of comprehensive international frameworks including IAEA Safety Standards Series SSR-6 (Rev. 1) and Nuclear Security Series NSS 46-T, the implementation and enforcement across African jurisdictions remains fragmented and inconsistent. This comprehensive analysis synthesizes findings from systematic literature review (2010-2024), comparative regulatory assessment across 15 African nations, and empirical data from major extractive operations in Niger, Namibia, South Africa, Nigeria, and Ghana. Through a multi-methodological approach incorporating quantitative exposure assessments, qualitative stakeholder interview with a regulatory official, and benchmarking analysis against IAEA general safety requirements (3-7 parts). This study reveals significant disparities in regulatory transposition, methodological inconsistencies in NORM characterization protocols, inadequate incident reporting mechanisms, and limited integration between safety and security frameworks. The research identifies exposure rates in certain operations exceeding ICRP and UNSCEAR public dose limits, with measured activities reaching 186 Bq/kg for ^{232}Th in artisanal mining sites and transport practices frequently diverging from established international protocols. Building upon these empirical findings, the paper proposes an integrated regulatory framework featuring harmonized classification matrices, standardized transport protocols, enhanced monitoring systems, and strengthened regional cooperation mechanisms through Forum of Nuclear Regulatory Bodies in Africa (FNRBA) and African Network for Education in Nuclear Science and Technology (AFRA-NEST) platforms. The proposed framework addresses critical gaps in current practices while providing actionable pathways for improving NORM transport safety and security across Africa's extractive value chains.

Country or International Organization

Instructions

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