

Assessment of Radiation Exposure and Radiological Security Risks in Scrap Metal Facilities and Waste Dumpsites in Dar es Salaam, Tanzania

Background: The increasing presence of radioactive materials in non-nuclear facilities such as scrap metal stores and waste dumpsites poses significant radiological safety and security threats to workers, the public, and the environment. In urban settings like Dar es Salaam, Tanzania, scrap metal yards and dumpsites are often located in close proximity to residential and commercial areas, raising concerns about uncontrolled radiation exposure and potential illicit trafficking of radioactive materials.

Objective: This study aimed to assess radiological safety and radiological security risks in selected scrap metal stores and dumpsites in Dar es Salaam.

Methods: The study was performed by evaluating the radiation exposure levels and radon exhalation rates in five scrap metal stores and three dumpsites in Dar es Salaam respectively. The radiation exposure rates were measured using an Ionization Chamber Survey Meter (ICSM) and a Gamma Scout Detector (GSD) while the radon (^{222}Rn) exhalation rates were measured using an AlphaGUARD radon monitor. Annual effective dose equivalent (AEDE) and excess lifetime cancer risk (ELCR) were calculated.

Results: The average radiation exposure rates ranged from $0.15 \pm 0.03 \mu\text{Sv/h}$ to $1.02 \pm 0.18 \mu\text{Sv/h}$. Store S₁ recorded the highest exposure ($1.41 \mu\text{Sv/h}$ at chest level), exceeding the ICRP public exposure limit of $0.57 \mu\text{Sv/h}$. Calculated AEDE values ranged from $1.76 \pm 0.57 \text{ mSv/y}$ to $9.55 \pm 1.22 \text{ mSv/y}$, all above the ICRP public limit of 1.0 mSv/y but below the occupational limit of 20 mSv/y . ELCR values ranged from $(5.79 \pm 1.56) \times 10^{-3}$ to $(31.42 \pm 4.01) \times 10^{-3}$, significantly higher than the global average of 0.29×10^{-3} . Meanwhile, the mean radon exhalation rates at dumpsites ranged from $123.0 \pm 10.0 \text{ mBq m}^{-2} \text{ h}^{-1}$ (Pugu-Kinyamwezi) to $216.0 \pm 40.0 \text{ mBq m}^{-2} \text{ h}^{-1}$ (Tabata). Yet, all radon concentrations remained below ICRP (300 Bq m^{-3}) and WHO (100 Bq m^{-3}) safety limits.

Conclusion: The findings reveal significant radiological safety and security concerns at scrap metal stores, where workers are exposed to radiation doses exceeding public limits, with elevated lifetime cancer risks. While radon levels at dumpsites remain within international safety thresholds, continuous monitoring is necessary to maintain these levels. Urgent regulatory interventions are recommended, including mandatory radiation screening protocols for scrap metal shipments, provision of personal dosimeters for workers, radiological safety training, and establishment of a centralized national database to track radioactive sources. These measures are essential to mitigate health risks, prevent illicit trafficking of nuclear materials, and enhance overall radiological security in Tanzania.

Keywords: Radiological safety, radiological security, radiation exposure, scrap metal, dumpsites, radon exhalation, annual effective dose equivalent, excess lifetime cancer risk, Dar es Salaam.

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