

Safety Assessment of Low and Intermediate Level Waste Disposal Facility

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INTRODUCTION AND GENERAL OBJECTIVE

Low and Intermediate Radioactive Wastes LILW are generated from diverse operation of facilities that uses radioactive materials. The increases recorded in the inventory of low level radioactive waste over the years, makes the need for the safe disposal of LILW wastes compelling.

Near surface disposal method in which LILW is buried just few meters above the ground has been used by most countries and is consistent with international recommendation.

In Nigeria, LILW is produced from the use of radioactive materials in the mining, petroleum, medical, research, manufacturing and the agricultural sectors. As a member of the international community, it must dispose the generated waste in a manner that is consistent with best practices recommended by the IAEA.

Safety Assessment in the context of radiation protection has one main objective: to ensure that the operational and post closure operation periods of a disposal facility provides reasonable assurance about safety of human health and protection of the environment.

The objective of this study is to demonstrate safety by conducting safety assessment on a hypothetical near surface disposal facility using RESRAD OFFSITE computer code.

Safety Assessment results provides important information regarding factors that influence the total predicted dose delivered to the public. This results could be justified and used in a graded manner by regulators to focus scarce resources and attention on factors influencing the safety of disposal facilities.

METHODOLOGY

The IAEA through the ISAM project presented a coordinated methodology to improve and harmonize the approach to safety assessment. Therefore developing a conceptual model consistent with the ISAM methodology is very imperative in order to help build public confidence and ensure transparency in the over all process.

To achieve the aim of the study, RESRAD OFFSITE version 3.2 computer code was employed to calculate the total effective dose equivalent via inhalation, ingestion of plant based food, meat milk, aquatic foods, soil and drinking water pathway. RESRAD is the industry standard for calculating site clean up criteria and evaluating the radiological impact of a contaminated site.

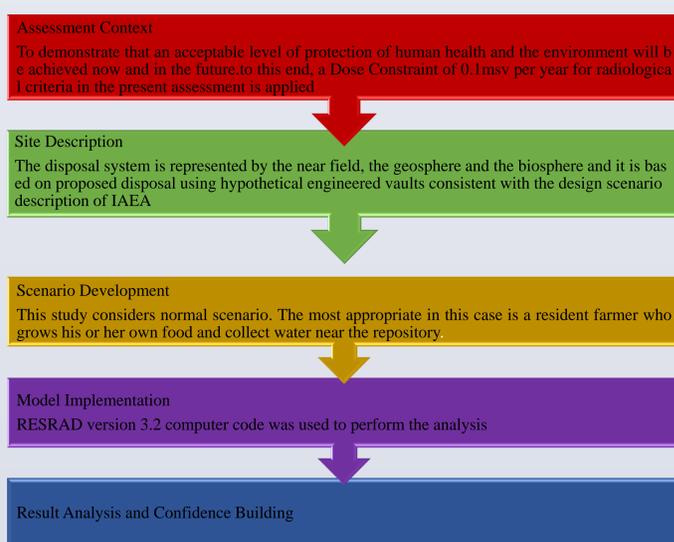


Fig 1: Key Components of ISAM Methodology

Site Description and Scenario Development

This study considers a scenario in which radionuclides leach from the disposal facility after its closure. RESRAD models radionuclides migration through the water pathway taking into account horizontal/vertical migration and calculates the radiological impact based on predicted radionuclide concentration. Radioactive waste inventory for this generic assessment is assumed to contain radionuclides that are commonly used in industry, research and medical applications in Nigeria. The waste is assumed to occupy an area of 2500m², be 1m thick, uniformly mixed with the soil and be covered by 5m thick of clean soil. With no engineered barriers, degradation was conservatively assumed to begin at time t=0 and a first order released mechanism was used. Also, default values for the Dose Conversion Factor based on ICRP 103 for each radionuclide was used.

Input parameters were selected to produce an unfavorable result from literature review while default parameters were applied appropriately

Radionuclides	Half-life (yr.)	Radionuclides concentration (Bq/year)
H-3	12.34E+00	1000
C-14	5.70E+03	10
Co-60	5.27E+00	1
Cs-137	30.06E+00	1
I-129	1.57E+07	0.1
Nb-94	0.36E+00	1
Ni-59	31.78E+00	1000
Ni-63	1.00E+02	1000
Pu-239	2.40E+02	1
Sr-90	28.81E+00	10
Tc-99	2.11E+05	10

Table 1: Radionuclide Inventory

Parameters	Value
Distance to surface water (m)	450
Precipitation amount (m/yr.)	1.2
Water consumption (l/yr.)	730
Distance from center of contamination to well (m)	300

Table 2: Site Specific Parameters

RESULTS AND DISCUSSION

Results of RESRAD simulation based on conservative input parameters shows the maximum total effective dose equivalent TEDE of 0.0786msv/year peaked at 105years. Although this maximum value does not exceed a dose constraint of 0.1msv/year required by the regulatory body, simulation results identifies C-14, H-3, I-129, Tc-99, Nb-94 and Pu-239 as the most important radionuclides that contributes to dose levels via the pathways. In addition, fish ingestion and drinking water pathways are the most significant in which dose is delivered to the receptor. See Fig 2 and 3 for more details

Sensitivity results shows factors that influence the total predicted dose levels and in this study, sensitivity to dose of the length parallel to aquifer flow, waste inventory, distance of contamination from well and the thickness of contaminated zone was investigated. See table 3

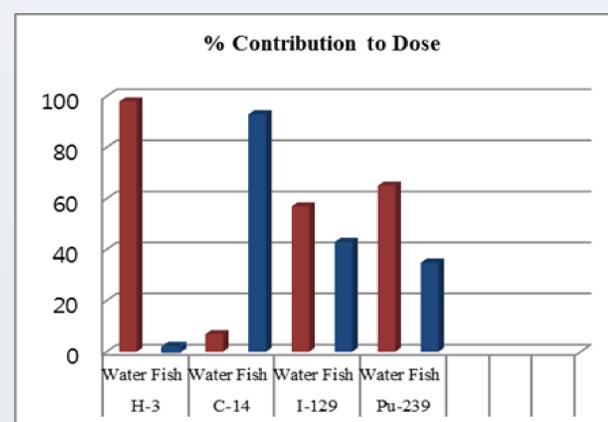


Fig 2: RESRAD output result showing fish and water ingestion pathways for H-3, C-14, I-129 and Pu-239

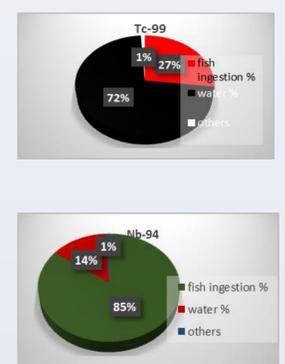


Fig. 3: RESRAD output results for Tc-99 and Nb-94. Approximately 1% of the dose is delivered through ingestion of milk, meat, soil and inhalation

parameter	Parameter value	Time of peak dose (yr.)	Maximum dose msv/yr.
Length parallel to aquifer	500	120	0.0424
flow	250 ^b	105	0.0786
	125	95	0.1782
Thickness of Contaminated zone	2	105	0.1639
	1 ^b	105	0.0786
	0.5	105	0.0381
Distance parallel to aquifer from contamination to well	600	105	0.0786
	300	105	0.0786
	150	105	0.0786
Waste inventory activity	Upper*	105	0.7857
	Baseline	105	0.0786
	Lower**	105	0.0007857

*Upper limit: radionuclide concentration was increased by a power of 10
** Lower limit: radionuclide concentration was reduced by a power of 10

CONCLUSION

In Nigeria, the current practice in which LILW from disused radioactive sources are kept in storage facilities is not only inconsistent with international best practices but is becoming impracticable. For this reason, a decision to construct a near surface disposal facility for LILW seems essential.

In order to ensure the protection of public health and the environment, a Near Surface Disposal Facility must meet the radiological protection criteria of 0.1msv/year of the predicted dose set out by the regulatory body.

Safety which is the first priority in the management of waste must be demonstrated at all stages to help build public confidence. Equally important is making an informed decision regarding site characterization, waste inventory criteria, disposal design and other important parameters to ensure that the dose constraint is not exceeded.

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User Manual for RESRAD –OFFSITE Version 2