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UNREVIEWED DISPOSAL QUESTION EVALUATION: Disposal of the Oak Ridge National Laboratory General Radioactive Sources at the Area 5 Radioactive Waste Management Site, Nevada National Security Site, Nye County, Nevada

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Prepared by

Mission Support and Test Services, LLC
Las Vegas, Nevada

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Acronyms and Abbreviations

Ba	barium
Bi	bismuth
BN	Bechtel Nevada
Bq	becquerel
Bq m^{-3}	becquerel per cubic meter
Bq m^{-2} s^{-1}	becquerel per square meter per second
Cl	chlorine
Cm	curium
Co	cobalt
Cs	cesium
DOE	U.S. Department of Energy
FY	(Federal) fiscal year
GM	geometric mean
GSD	geometric standard deviation
^{3}H	tritium
Hg	mercury
Ho	holmium
I	iodine
LHS	Latin hypercube sample
LLRW	low-level radioactive waste
m	meter(s)
mSv	millisievert(s)
Ni	nickel
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
ORNL	Oak Ridge National Laboratory
PA	Performance Assessment
Pa	protactinium
Pb	lead
Pu	plutonium
Ra	radium
Rn	radon
RWMS	Radioactive Waste Management Site

SLB	shallow land burial
SOFs	sum of fractions
Sr	strontium
Tc	technetium
TED	total effective dose
Th	thorium
U	uranium
UDQE	unreviewed disposal question evaluation
UL	upper limit
WAC	Waste Acceptance Criteria
WARP	Waste Acceptance Review Panel
y	years

1.0 Executive Summary

This Unreviewed Disposal Question Evaluation (UDQE) assesses whether the Oak Ridge National Laboratory (ORNL) General Radioactive Sources (ORNLSOURCES01, Revision 6 [ORNL 2021]) is suitable for shallow land burial (SLB) at the Area 5 Radioactive Waste Management Site (RWMS) on the Nevada National Security Site (NNSS). Disposal of the ORNL General Radioactive Sources meets all performance objectives of DOE Manual DOE M 435.1-1, *Radioactive Waste Management Manual*, Chapter IV, Section P (DOE 1999). The ORNL General Radioactive Stream is recommended for acceptance with the following conditions on the total waste stream activities:

- Total tritium (^{3}H) activity shall not exceed 4.1E+10 Bq
- Total cobalt-60 (^{60}Co) activity shall not exceed 3.6E+10 Bq
- Total strontium-90 (^{90}Sr) activity shall not exceed 2.8E+12 Bq
- Total technetium-99 (^{99}Tc) activity shall not exceed 3.6E+09 Bq
- Total cesium-137 (^{137}Cs) activity shall not exceed 1.2E+11 Bq
- Total holmium-166m (^{166m}Ho) activity shall not exceed 5.0E+05 Bq
- Total protactinium-231 (^{231}Pa) activity shall not exceed 5.5E+04 Bq
- Total radium-226 (^{226}Ra) activity shall not exceed 1.7E+10 Bq
- Total thorium-232 (^{232}Th) activity shall not exceed 7.2E+05 Bq
- Total uranium-234 (^{234}U) activity shall not exceed 2.2E+09 Bq
- Total ^{238}U activity shall not exceed 5.2E+08 Bq, and
- Total plutonium-241 (^{241}Pu) activity shall not exceed 7.2E+08 Bq.

2.0 Introduction

This UDQE addresses disposal of the ORNL General Radioactive Sources at the Area 5 RWMS on the NNSS. The waste stream requires a UDQE because 26 radionuclides exceed their NNSS Waste Acceptance Criteria (WAC) Action Levels (U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office [NNSA/NFO] 2016).

3.0 Analysis of Performance

The UDQE addresses the long-term performance of the Area 5 RWMS with the ORNL General Radioactive Sources disposed in a shallow land burial (SLB) disposal cell.

3.1 Waste Description

The ORNL General Radioactive Sources waste stream consists of radioactive sources manufactured, procured, or used at ORNL (ORNL 2021). The sources are not from the Off-Site Source Recovery Program.

The ORNL General Radioactive Sources radionuclide activities are assumed to be lognormally distributed. The geometric mean of the distribution is assumed to be the product of the representative activity concentration and the total remaining volume, 12.53 m^3, as reported on the waste profile (ORNL 2021, Section D.5), except for tritium (^{3}H), cobalt-60 (^{60}Co), strontium-90 (^{90}Sr), technetium-99 (^{99}Tc), cesium-137 (^{137}Cs), holmium (^{166m}Ho), protactinium (^{231}Pa), radium-226 (^{226}Ra), thorium-232 (^{232}Th), uranium-234 (^{234}U), ^{238}U, and plutonium-241 (^{241}Pu) (Table 1). The geometric mean concentration of these radionuclides is assumed to be the total activity estimated by the generator divided by the waste stream volume (WARP 2021).

Table 1. ORNL General Radioactive Sources Activity Concentration and Total Activity at the Time of Disposal Assumed for Performance Assessment Modeling

Nuclide	GM† Concentration (Bq m^{-3})	95th Percentile Concentration (Bq m^{-3})	GM Activity (Bq)	95th Percentile Activity (Bq)	GSD‡
^{241}Am	3.3E+08	4.0E+09	4.1E+09	5.0E+10	4.54
^{133}Ba	1.8E+13	5.9E+14	2.2E+14	7.4E+15	8.41
^{207}Bi	2.7E+12	9.2E+12	3.4E+13	1.1E+14	2.08
^{14}C	1.4E+10	8.3E+10	1.7E+11	1.0E+12	2.96
^{249}Cf	9.5E+09	2.8E+10	1.2E+11	3.5E+11	1.94
^{250}Cf	1.2E+11	3.6E+11	1.5E+12	4.5E+12	1.94
^{251}Cf	6.3E+09	1.9E+10	7.8E+10	2.3E+11	1.94
^{36}Cl	2.9E+09	7.8E+09	3.6E+10	9.8E+10	1.83
^{244}Cm	3.0E+15	5.9E+16	3.7E+16	7.4E+17	6.08
^{245}Cm	2.3E+07	6.7E+07	2.8E+08	8.4E+08	1.94
^{246}Cm	2.6E+09	7.7E+09	3.2E+10	9.6E+10	1.95
^{247}Cm	8.0E+03	2.4E+04	1.0E+05	3.0E+05	1.95
^{248}Cm	2.8E+08	1.2E+09	3.5E+09	1.5E+10	2.44
^{60}Co	2.3E+09	2.8E+09	2.8E+10†	3.5E+10*	1.14
^{137}Cs	7.6E+09	9.5E+09	9.6E+10†	1.2E+11*	1.14
^{152}Eu	2.2E+12	1.2E+13	2.8E+13	1.5E+14	2.82
^{154}Eu	2.5E+11	6.1E+11	3.1E+12	7.6E+12	1.72
^{3}H	2.6E+09	3.3E+09	3.3E+10§	4.1E+10*	1.14
^{166m}Ho	3.5E+04	4.0E+04	4.4E+05§	5.0E+05*	1.08
^{129}I	3.5E+10	7.1E+10	4.4E+11	8.9E+11	1.53
^{40}K	9.0E+05	1.1E+08	1.1E+07	1.3E+09	18.1
^{85}Kr	1.2E+16	1.2E+17	1.5E+17	1.5E+18	4.00
^{63}Ni	6.2E+15	8.8E+15	7.8E+16	1.1E+17	1.24
^{237}Np	1.6E+09	3.3E+09	2.0E+10	4.1E+10	1.57
^{231}Pa	4.4E+01	4.4E+03	5.5E+02§	5.5E+04*	16.3
^{210}Pb	1.4E+13	6.2E+13	1.7E+14	7.7E+14	2.48
^{238}Pu	2.4E+07	4.8E+08	3.0E+08	6.0E+09	6.14
^{239}Pu	1.6E+09	4.0E+09	2.0E+10	5.1E+10	1.74
^{240}Pu	1.2E+09	3.5E+09	1.5E+10	4.4E+10	1.95
^{241}Pu	5.0E+07	5.7E+07	6.3E+08§	7.2E+08*	1.08
^{242}Pu	2.5E+07	2.5E+09	3.1E+08	3.1E+10	16.4
^{244}Pu	1.0E-05	1.0E-04	1.3E-04	1.3E-03	4.04
^{226}Ra	1.0E+09	1.3E+09	1.3E+10§	1.6E+10*	1.14
^{228}Ra	2.6E-06	5.2E-06	3.3E-05	6.5E-05	1.52
^{90}Sr	1.7E+11	2.2E+11	2.2E+12§	2.7E+12*	1.14
^{99}Tc	2.3E+08	2.8E+08	2.8E+09§	3.5E+09*	1.15

Nuclide	GM† Concentration (Bq m^{-3})	95th Percentile Concentration (Bq m^{-3})	GM Activity (Bq)	95th Percentile Activity (Bq)	GSD‡
^{228}Th	1.2E+10	2.1E+16	1.5E+11	2.6E+17	5981
^{229}Th	2.9E+11	5.9E+11	3.7E+12	7.4E+12	1.52
^{230}Th	1.0E+09	4.7E+10	1.3E+10	5.9E+11	10.3
^{232}Th	4.6E+04	5.7E+04	5.7E+05§	7.1E+05*	1.14
^{232}U	1.2E+14	2.9E+14	1.4E+15	3.7E+15	1.77
^{233}U	1.0E+11	5.5E+11	1.3E+12	6.9E+12	2.73
^{234}U	1.4E+08	1.7E+08	1.7E+09§	2.1E+09*	1.14
^{235}U	5.3E+11	6.2E+12	6.6E+12	7.7E+13	4.43
^{236}U	4.5E+11	1.1E+12	5.6E+12	1.3E+13	1.68
^{238}U	3.3E+07	4.1E+07	4.1E+08§	5.2E+08*	1.14

† GM – geometric mean
‡ GSD – geometric standard deviation
§ - GM is the expected total activity estimated by generator (WARP 2021)
*- 95th percentile is the upper limit activity estimated by generator (WARP 2021)

The high activity concentration (upper limit, *UL*) is assumed to be the 95th percentile of the lognormal distribution. The geometric standard deviation of the lognormal distribution is calculated as:

$$GSD = e^{\frac{\ln(UL) - \ln(GM)}{1.65}}$$

where

GSD = geometric standard deviation (dimensionless)
UL = 95th percentile activity, Bq
GM = geometric mean, Bq

The 95th percentile concentration of ^{3}H, ^{60}Co, ^{90}Sr, ^{99}Tc, ^{137}Cs, ^{166m}Ho, ^{231}Pa, ^{226}Ra, ^{232}Th, ^{234}U, ^{238}U, and ^{241}Pu is the upper limit activity estimated by the generator divided by the waste stream volume (WARP 2021). The lognormal distributions are truncated at the 95th percentile due to the high geometric standard deviations estimated for some radionuclides. The generator is prohibited from shipping waste above the upper limit concentration.

The ORNL General Radioactive Sources, revision 6, requires a UDQE because 26 radionuclides exceed the WAC Action Level. The ORNL General Radioactive Sources significantly increases the inventory of nine radionuclides: chlorine-36 (^{36}Cl), nickel-63 (^{63}Ni), iodine-129 (^{129}I), barium-133 (^{133}Ba), bismuth-207 (^{207}Bi), lead-210 (^{210}Pb), ^{232}U, ^{229}Th, and curium-244 (^{244}Cm) (Table 2). The generator has reported the concentration averaged over the volume of the radioactive source. This approach results in extremely high concentrations that when multiplied by the very large waste stream volume generates high total activity estimates. The actual activity disposed is expected to be much less than estimated in Table 2.

Table 2. Expected Increase in the Disposed Inventory of Radionuclides Exceeding Their Action Levels and the Area 5 RWMS sum of fractions (SOFs) at Closure (10/1/2028)

Nuclide	FY 2020* SLB Disposed GM Inventory	ORNLSOURCES01_6 GM Inventory	Relative Percent Change
^{226}Ra	1.6E+12 Bq	1.3E+10 Bq	8.1E-01
^{231}Pa	1.2E+10 Bq	5.5E+02 Bq	4.6E-06
^{99}Tc	9.7E+14 Bq	2.8E+09 Bq	2.9E-04
^{3}H	3.6E+16 Bq	3.3E+10 Bq	9.2E-05
^{137}Cs	8.9E+14 Bq	9.6E+10 Bq	1.1E-02
^{234}U	1.9E+14 Bq	1.7E+09 Bq	8.9E-04
^{90}Sr	1.2E+14 Bq	2.2E+12 Bq	1.8E+00
^{232}U	2.8E+12 Bq	1.4E+15 Bq	5.0E+04
^{60}Co	2.6E+15 Bq	2.8E+10 Bq	1.1E-03
^{244}Cm	3.6E+12 Bq	3.7E+16 Bq	1.0E+06
^{241}Pu	4.5E+13 Bq	6.3E+08 Bq	1.4E-03
^{166m}Ho	6.3E+08 Bq	4.4E+05 Bq	7.0E-02
^{238}U	4.4E+14 Bq	4.1E+08 Bq	9.3E-05
^{232}Th	7.7E+11 Bq	5.7E+05 Bq	7.4E-05
^{210}Pb	1.0E+12 Bq	1.7E+14 Bq	1.7E+04
^{207}Bi	2.0E+07 Bq	3.4E+13 Bq	1.7E+08
^{63}Ni	3.3E+14 Bq	7.8E+16 Bq	2.4E+04
^{230}Th	7.3E+11 Bq	1.3E+10 Bq	1.8E+00
^{36}Cl	3.0E+09 Bq	3.6E+10 Bq	1.2E+03
^{229}Th	7.3E+11 Bq	3.7E+12 Bq	5.1E+02
^{129}I	1.6E+10 Bq	4.4E+11 Bq	2.8E+03
^{235}U	8.2E+12 Bq	6.6E+12 Bq	8.0E+01
^{152}Eu	4.4E+13 Bq	2.8E+13 Bq	6.4E+01
^{133}Ba	8.3E+10 Bq	2.2E+14 Bq	2.7E+05
^{236}U	7.8E+12 Bq	5.6E+12 Bq	7.2E+01
^{233}U	1.8E+14 Bq	1.3E+12 Bq	7.2E-01
SLB SOFs	0.80	0.91	14

*FY – fiscal year

3.2 Performance Assessment Modeling

The performance assessment (PA) modeling adds the inventory of the ORNL General Radioactive Stream to the Area 5 RWMS v4.208ba model and determines if there is a reasonable expectation of meeting the performance objectives of DOE M 435.1-1, *Radioactive Waste Management Manual*, Chapter IV, Section P (DOE 1999). The PA model evaluates the ORNL General Radioactive Stream radionuclide activity added to the inventory of post-1988 SLB waste disposed through FY 2020. The UDQE inventory also includes the Pit 6, Pit 13, and post-1988 Greater Confinement Disposal borehole inventories. The model is run with a 2.5-meter (m) closure cover for SLB disposal units.

The mean and median model results are calculated using 5,000 Latin hypercube samples (LHS). A sample size of 5,000 provides stable estimates of the mean and 95th percentile results of the PA model (Bechtel Nevada [BN] 2006). A reasonable expectation of compliance with the performance objectives is assumed if the mean and median are less than the performance objectives for 1,000 years after closure. In every case, the mean was greater than the median. The UDQE only reports the mean results.

For comparison purposes, baseline results are obtained by running the model with the inventory disposed through FY 2020 and without the ORNL General Radioactive Sources.

4.0 Results and Interpretation

4.1 Performance Assessment Results

4.1.1 Air Pathway Results

The air pathway annual total effective dose (TED) is evaluated for the resident exposure scenario using 5,000 LHS realizations. The resident exposure scenario estimates the dose to a representative person residing in a home at the 100-m Area 5 RWMS boundary. A complete description of the exposure scenario can be found in the earlier PA documentation (BN 2006).

The annual TED is calculated for a period of 1,000 years after closure. The maximum mean and 95th percentile annual TED occur at 1,000 years and are both less than the 0.1 millisievert (mSv) limit (Table 3). Addition of the ORNL General Radioactive Sources increases the maximum resident air pathway TED.

Table 3. Maximum Air Pathway Annual TED for a Resident at the Area 5 RWMS 100-m Site Boundary and the Waste Inventory Disposed through FY 2020

Scenario	Time of Maximum†	Mean (mSv)	95th Percentile (mSv)
Resident without ORNLSOURCES01_6 Waste Stream	1,000 y	1.4E-4	4.4E-4
Resident with ORNLSOURCES01_6 Waste Stream	1,000 y	3.1E-4	1.2E-3

† - years after closure

Addition of the ORNL General Radioactive Sources waste stream increases the air pathway mean annual TED throughout the compliance period. The maximum relative increase, 211%, occurs at 140 years (Figure 1).

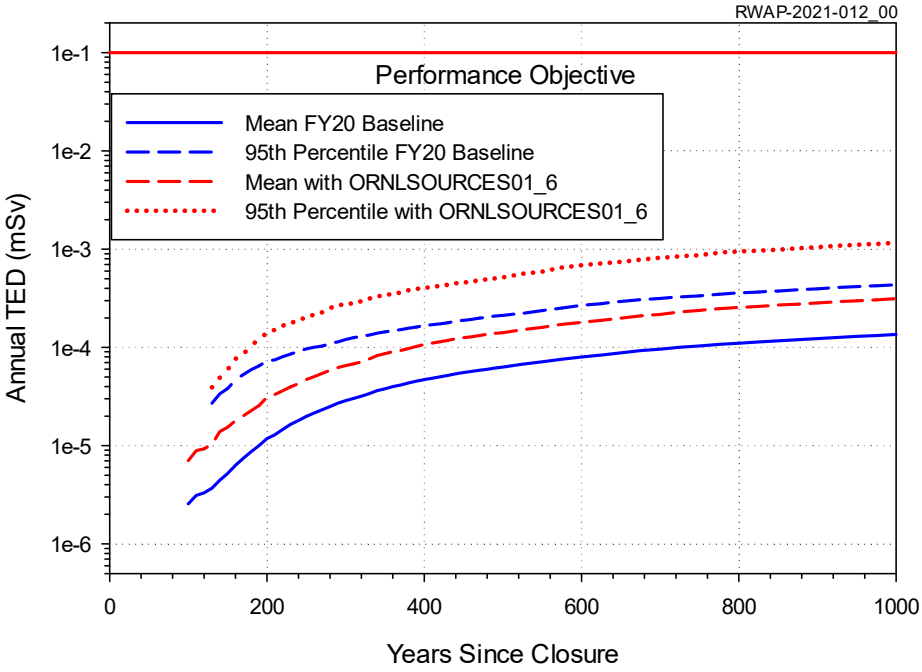

Figure 1. Air Pathway Annual TED Time History for a Resident at the 100-m Boundary with and without the ORNLSOURCES01_6 Waste Stream

4.1.1.1 Alternative Air Pathway Scenarios

Uncertainty contributed by the selected exposure scenario was evaluated by calculating the air pathway annual TED for alternative scenarios. The scenarios evaluated are the transient occupancy scenario, the resident with agriculture scenario, and open rangeland scenarios for a ranch at two plausible locations: one at the NNSS boundary closest to the Area 5 RWMS and another at Cane Spring. The scenarios and their assumptions are described in the PA (BN 2006).

The maximum of the mean and the 95th percentile TEDs are all less than the performance objective for all of the alternative scenarios (Table 4). Although the exposure scenario is a source of uncertainty, there is a high likelihood of compliance for a range of reasonable scenarios. Addition of the ORNL General Radioactive Sources increases the maximum result for all scenarios.

Table 4. Maximum Air Pathway Annual TEDs for Alternative Scenarios with the FY 2020 Inventory

Scenario	Inventory	Time of Maximum	Mean (mSv)	95th Percentile (mSv)
Transient Occupancy	FY 2020 Baseline Inventory	1,000 y	5.5E-5	1.8E-4
	FY 2020 with ORNLSOURCES01_6	1,000 y	1.3E-4	4.9E-4
Resident with Agriculture	FY 2020 Baseline Inventory	1,000 y	2.9E-4	9.6E-3
	FY 2020 with ORNLSOURCES01_6	1,000 y	6.8E-4	2.5E-3
Open Rangeland/Cane Spring	FY 2020 Baseline Inventory	1,000 y	4.1E-9	1.1E-8
	FY 2020 with ORNLSOURCES01_6	1,000 y	1.0E-8	2.5E-8
Open Rangeland/NNSS Boundary	FY 2020 Baseline Inventory	1,000 y	7.0E-8	1.9E-7
	FY 2020 with ORNLSOURCES01_6	1,000 y	1.7E-7	4.3E-7

4.1.2 All-Pathways Results

The all-pathways annual TED is also calculated for the resident exposure scenario. The maximum mean and 95th percentile resident all-pathways annual TEDs are less than the 0.25 mSv limit (Table 5). Addition of the ORNL General Radioactive Sources increases the maximum resident all-pathways annual TED.

Table 5. Maximum All-Pathways Annual TED for a Resident at the Area 5 RWMS 100-m Site Boundary and the Waste Inventory Disposed through FY 2020

Scenario	Time of Maximum	Mean (mSv)	95th Percentile (mSv)
Resident without ORNLSOURCES01_6 Waste Stream	1,000 y	9.8E-4	2.5E-3
Resident with ORNLSOURCES01_6 Waste Stream	1,000 y	1.2E-3	3.4E-3

Addition of the ORNL General Radioactive Sources waste stream increases the all-pathways TED throughout the compliance period. The maximum relative increase in the all-pathways annual TED is 269% at 110 years (Figure 2). The early increase is due to ^{228}Th, which has a large GSD. At 1,000 years, the increase is due to ^{240}Pu produced by decay of ^{244}Cm.

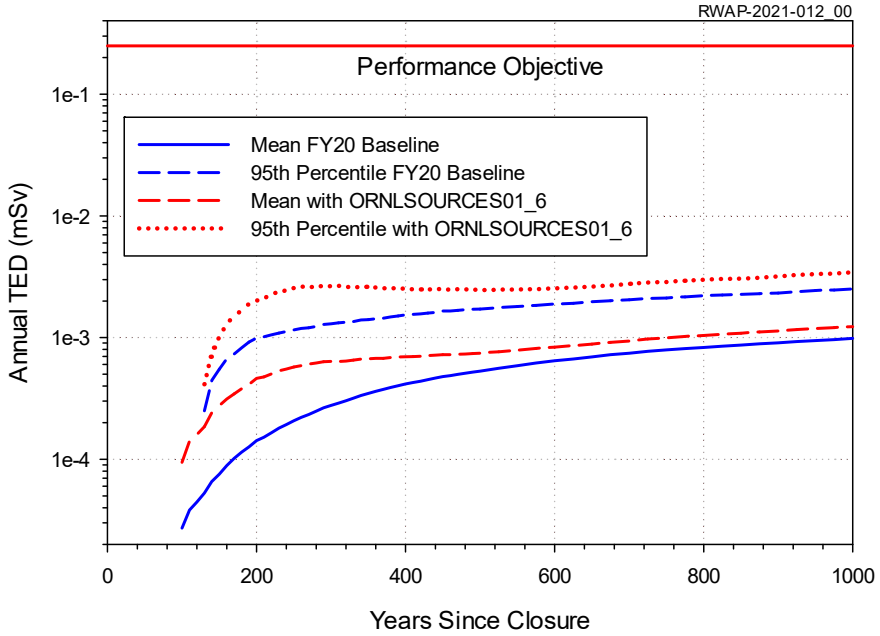

Figure 2. All-Pathways Annual TED Time History for a Resident at the 100-m Boundary with and without ORNLSOURCES01_6 Waste Stream

4.1.2.1 Alternative All-Pathways Scenarios

Uncertainty contributed by the selected exposure scenarios was evaluated by calculating the all-pathways annual TED for alternative scenarios. The scenarios evaluated are the transient occupancy scenario, the resident with agriculture scenario, and open rangeland scenarios for a ranch with two plausible exposure locations: one at the NNSS boundary closest to the Area 5 RWMS and another at Cane Spring. The scenarios and their assumptions are described in the PA (BN 2006).

The mean and 95th percentile all-pathways annual TEDs are all less than the performance objective for all alternative scenarios (Table 6). Although the exposure scenario is a source of uncertainty, there is a high likelihood of compliance for a range of reasonable scenarios. Addition of the ORNL General Radioactive Sources has no significant effect on the maximum annual TED for all alternate scenarios, except the transient occupancy scenario.

Table 6. Maximum All-Pathways Annual TEDs for Alternative Scenarios

Scenario	Inventory	Time of Maximum	Mean (mSv)	95th Percentile (mSv)
Transient Occupancy	FY 2020 Baseline Inventory	1,000 y	7.2E-3	1.7E-2
	FY 2020 with ORNLSOURCES01_6	1,000 y	7.4E-3	1.7E-2
Resident with Agriculture	FY 2020 Baseline Inventory	1,000 y	2.7E-2	8.5E-2
	FY 2020 with ORNLSOURCES01_6	1,000 y	2.7E-2	8.6E-2
Open Rangeland/Cane Spring	FY 2020 Baseline Inventory	1,000 y	4.7E-3	1.6E-2
	FY 2020 with ORNLSOURCES01_6	1,000 y	4.7E-3	1.6E-2
Open Rangeland/NNSS Boundary	FY 2020 Baseline Inventory	1,000 y	4.9E-3	1.7E-2
	FY 2020 with ORNLSOURCES01_6	1,000 y	4.9E-3	1.7E-2

4.1.3 Intruder Results

Intruder results are evaluated for acute intruder scenarios only. NNSA/NFO institutional control policy is to maintain and enforce use restrictions (NNSA/NFO 2019). The proposed land-use restrictions are assumed to eliminate the possibility of chronic intrusion for 1,000 years.

The acute drilling scenario estimates the TED to a drill crew drilling a water well through a disposal unit. Exposure to contaminated drill cuttings occurs while augering a surface casing for the well. The acute construction scenario estimates the dose to construction workers building a residence on a disposal unit. Construction workers are exposed to waste exhumed from the construction excavation.

The maximum mean acute intruder TEDs shift from 1,000 years to 200 years for the acute drilling scenario and 230 years for the acute construction scenario. The maximum mean acute intruder TED remains less than the 5 mSv performance measure for both the drilling and construction acute intrusion scenarios (Table 7). Addition of the ORNL General Radioactive Sources increases the maximum acute intruder scenario mean result and shifts the maximum to an earlier time.

Table 7. Maximum TED for Acute Intrusion Scenarios at the Area 5 RWMS and the Waste Inventory Disposed through FY 2020

Scenario	Time of Maximum	Mean (mSv)	95th Percentile (mSv)
Drilling Intruder without ORNLSOURCES01_6	1,000 y	1.5E-3	2.5E-3
Drilling Intruder with ORNLSOURCES01_6	200 y	2.4E-3	1.6E-2
Construction Intruder without ORNLSOURCES01_6	1,000 y	0.76	1.2
Construction Intruder with ORNLSOURCES01_6	230 y	1.8	10.2

Addition of the ORNL General Radioactive Sources increases the mean acute construction TED throughout the compliance period. The maximum relative increase, 703%, occurs at 190 years (Figure 3). The 95th percentile TED exceeds the performance measure from closure until 370 years after closure. The early increase is due predominantly to ^{228}Th.

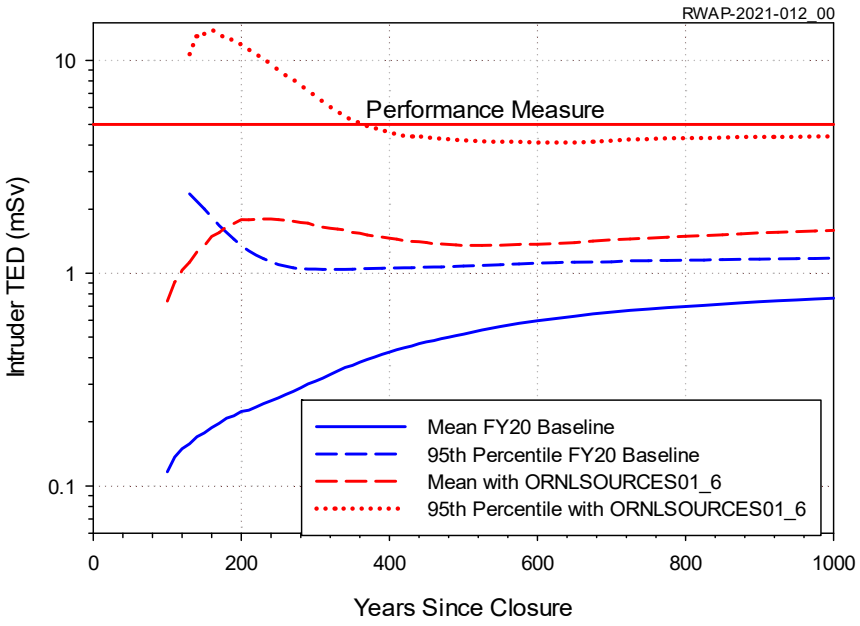

Figure 3. Acute Construction Intrusion Scenario TED Time History with and without the ORNLSOURCES01_6 Waste Stream

4.1.4 ^{222}Rn Flux Density Results

The radon-222 (^{222}Rn) flux density is averaged over the area of all post-1988 disposal cells. The maximum mean and 95th percentile ^{222}Rn flux densities occur at 1,000 years and are less than the 0.74 becquerel per square meter per second (Bq m^{-2} s^{-1}) performance objective (Table 8).

Addition of the ORNL General Radioactive Sources has no significant effect on the maximum ^{222}Rn flux density at 1,000 years. This waste stream does not require an increased depth of burial to attenuate ^{222}Rn flux.

Table 8. Maximum ^{222}Rn Flux Density at the Area 5 RWMS and the Waste Inventory Disposed through FY 2020

Inventory	Time of Maximum	Mean (Bq m^{-2} s^{-1})	95th Percentile (Bq m^{-2} s^{-1})
FY 2020 without ORNLSOURCES01_6	1,000 y	0.26	0.55
FY 2020 with ORNLSOURCES01_6	1,000 y	0.26	0.56

Addition of the ORNL General Radioactive Sources has no significant effect on the mean ^{222}Rn flux density throughout the compliance period (Figure 4). The maximum relative increase, 1.2%, occurs at 1,000 years.

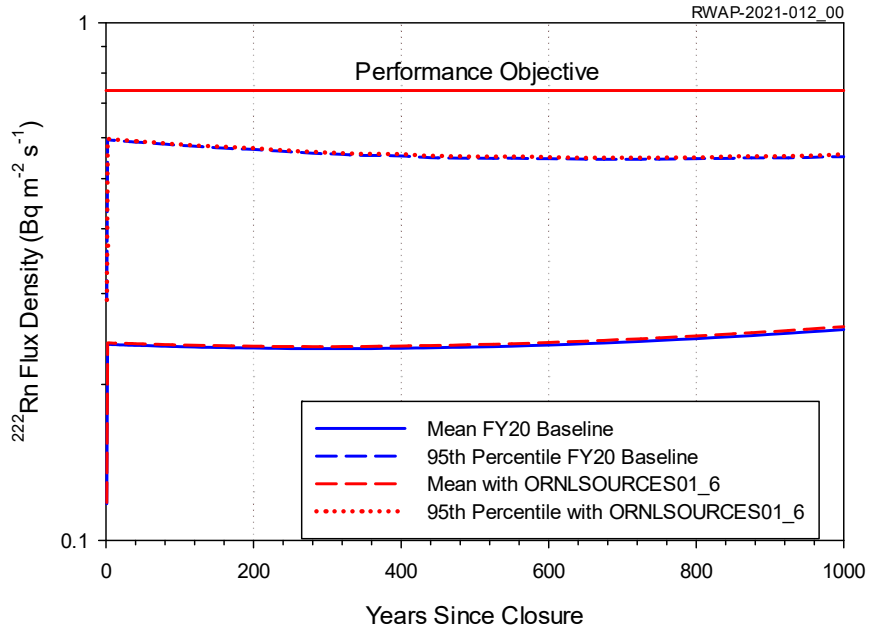

Figure 4. ^{222}Rn Flux Density Time History with and without the ORNLSOURCES01_6 Waste Stream

5.0 Conclusions

The effect of adding the ORNL General Radioactive Sources inventory to the inventory of waste disposed through the end of FY 2020 was evaluated with the Area 5 RWMS v 4.208ba PA model. The results indicate that all performance objectives can be met for 1,000 years with disposal of the ORNL General Radioactive Sources in an Area 5 RWMS SLB disposal cell. Addition of the ORNL General Radioactive Sources inventory increases most PA results, but the results are expected to be overestimated. All maximum mean and 95th percentile results remain less than their respective performance objectives throughout the compliance period, except the 95th percentile TED for the acute construction intruder scenario. No mean result exceeds the Low-Level Radioactive Waste Review Group notification criterion of exceeding 50% of a performance objective. The ORNL General Radioactive Sources is acceptable for disposal with the following conditions on total activity:

- Total ^{3}H activity shall not exceed 4.1E+10 Bq
- Total ^{60}Co activity shall not exceed 3.6E+10 Bq
- Total ^{90}Sr activity shall not exceed 2.8E+12 Bq
- Total ^{99}Tc activity shall not exceed 3.6E+09 Bq
- Total ^{137}Cs activity shall not exceed 1.2E+11 Bq
- Total ^{166m}Ho activity shall not exceed 5.0E+05 Bq
- Total ^{231}Pa activity shall not exceed 5.5E+04 Bq
- Total ^{226}Ra activity shall not exceed 1.7E+10 Bq
- Total ^{232}Th activity shall not exceed 7.2E+05 Bq
- Total ^{234}U activity shall not exceed 2.2E+09 Bq
- Total ^{238}U activity shall not exceed 5.2E+08 Bq, and
- Total ^{241}Pu activity shall not exceed 7.2E+08 Bq.

6.0 References

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