Attachment 2

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NRC RAIs
MDNR Tobico Marsh SGA DP, Revision 1

Dose from LCTS System Operation

MicroShield Version 6.02 Calculations

Print

MicroShield v6.02 (6.02-00140)

MACTEC Development Corp.

Page	:1	**File Ref**	: Response to NRC RAIs
DOS File	:Tobico LCTS Exposure.ms6	**Date**	: October 8, 2004
Run Date	: October 8, 2004	**By**	: Jeffrey W. Lively
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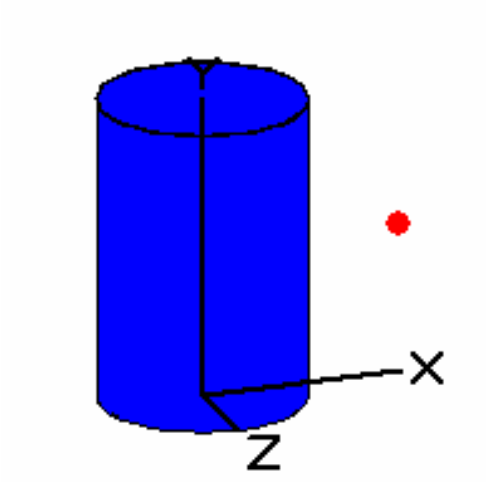
Case Title: MDNR Tobico SGA Site
Description: Calculate Exposure to Workers Involved in Future LCTS Operations
Geometry: Cylinder Volume - Side Shields (#7)
Scenario: Simulates a large tank or vessel containing leachate from the MDNR cell. The source term is derived from the RESRAD Model (Leakage Scenario) and is equal to the highest concentration of radioactivity present in the leachate at any time (1000 years)



Source Dimensions:

Height	300.0 cm	(9 ft 10.1 in)
Radius	100.0 cm	(3 ft 3.4 in)

Dose Points

A	X	Y	Z
# 1	200.15 cm	150 cm	0 cm
	6 ft 6.8 in	4 ft 11.1 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	9.42e+06 cm³	Water	1
Transition		Air	0.00122
Air Gap		Air	0.00122
Wall Clad	.15 cm	Iron	7.8
Top Clad	.15 cm	Iron	7.8

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Pb-210	3.7888e-006	1.4018e+005	4.0200e-007	1.4874e-002
Ra-226	6.5219e-006	2.4131e+005	6.9200e-007	2.5604e-002
Ra-228	2.5604e-002			
Th-228	2.5604e-002			
Th-230	2.5604e-002			
Th-232	2.5604e-002			

Buildup : The material reference is - Source

Integration Parameters

Radial	10
Circumferential	10
Y Direction (axial)	20

Case Title: MDNR Tobico SGA Site

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0108	3.410e+04	1.207e-36	1.174e-29	2.904e-37	2.826e-30
0.0117	1.936e+03	7.421e-38	7.221e-31	1.390e-38	1.352e-31
0.0465	5.677e+03	4.477e-07	9.570e-06	1.384e-09	2.959e-08
0.0811	4.349e+02	1.051e-06	1.432e-05	1.655e-09	2.256e-08
0.0838	7.224e+02	1.937e-06	2.538e-05	3.021e-09	3.957e-08
0.0949	3.275e+02	1.245e-06	1.410e-05	1.905e-09	2.158e-08
0.1862	7.915e+03	1.068e-04	6.659e-04	1.855e-07	1.156e-06
0.3097	1.610e+01	4.655e-07	1.996e-06	8.864e-10	3.801e-09
Totals	**5.113e+04**	**1.120e-04**	**7.313e-04**	**1.944e-07**	**1.274e-06**

Conclusion:

MDNR chose to perform a conservative, bounding calculation to assess the theoretical possible future dose to workers or visitors from an operating LCTS. While it is considered an unlikely prospect, based upon conversations with representatives of S.C. Holdings, MDNR's dose assessment assumes that a large leachate-holding tank will be installed at the site. (Note: S.C. Holdings indicated to MDNR that their plan is to pipe leachate extracted from the MDNR cell directly to a single, common leachate collection/processing facility located at on the Waste Management Site property.) The assumption that a large leachate-holding tank will be installed at the MDNR site is bounding in that it represents a potential source term far larger than would be possible with above ground piping or other smaller vessels and containers that might be envisioned.

The conceptual tank containing leachate from the MDNR cell is assumed to have a large capacity (≈ 10,000 liters or 2,500 gal.) and is modeled completely full of leachate. The concentration of residual radioactivity assumed present in the leachate is taken from the maximum concentration projected over the 1000-year outlook by RESRAD using the "system leakage" scenario described in Attachment 1. The "system leakage" scenario itself is exceptionally conservative in that it assumes the presence of thorium radioactivity in slag at the specific activity limit.

The MicroShield photon transport modeling code projects a maximum potential gamma radiation exposure rate at a distance of 1 meter from the tank of 1.27 x 10^{-6} mR/h. Assuming a worker spent an entire work year in immediate proximity to an operating LCTS system under prohibitively unlikely radiological conditions, the resulting annual gamma radiation dose would be well less than 1 mrem/y.

$$H_A = R_{EXP} * t$$

Where:

- H_A is the annual external gamma radiation dose
- R_{EXP} is the calculated gamma exposure rate in mR/h
- t is the worker's annual exposure time in hours per year

$$H_A = \left(1.27 x 10^{-6} \frac{mR}{h}\right) * \left(\frac{2000\,h}{y}\right) = 0.003\,mR/y$$

Even if one were to assume that a number of such vessels were present as components of the LCTS operation, the resulting dose to the most exposed individuals would be well less than 1 mrem/year.