September 10, 2004

SUBJECT: TENORM BLANKET AUTHORIZATION FOR DISPOSAL

TO: BRP AREA HEALTH PHYSICISTS

FROM: RAY URCIUOLO
CHIEF, DIV. RADIATION CONTROL

In October 2002, the regions were provided with A TENORM blanket authorization that allowed disposal of TENORM that exhibited dose rates of up to 30 uR/hr if the number of these trucks was less than 2% of the total number of trucks allowed into a facility to dump waste. This authorization is overly restrictive. The following limits may be used at a facility if deemed appropriate by the Area Health Physicist. Please note the preferred method of using this authorization is to determine the number of loads of TENORM that would cause an alarm at the facility and then impose the corresponding dose rate limit from the table below. Action Plans are now being approved with the statement that the AHP will authorize disposal of TENORM on a case-by-case basis. The AHP may choose to be informed of each load or give the facility bounding conditions, it is your choice.

TENORM fraction of the total input	Dose Rate contact with roll-off or truck cargo area
0.5 %	140 uR/hr
1.0 %	70 uR/hr
2.0 %	35 uR/hr

The Central Office will review the facility annual reports and verify conformance with this authorization. Loads that exceed these limits will continue to be evaluated by the Central Office. Please call me if you have any questions regarding this authorization.

Coal ash is not included in the above TENORM authorization. Due to the vitreous nature of coal ash, the release of radon is inhibited and the same amount of radioactivity is less harmful than other forms of TENORM. A separate evaluation shows that coal ash that exhibits contact vehicle dose rates of less than 20 uR/hr can be 100 % of the landfill volume.

Please call me if you have any questions regarding either of these evaluations.

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EVALUATION OF LANDFILL TENORM DISPOSAL

Originator: R.F. Crow 9-18-02
Technical Review: AJ Lombardo, CHP 9/20/02
Concurrence: Lok Atmon 9/24/02
Concurrence: Louis Ray Urciuolo 9-24-02
Concurrence: _____

1.0 Purpose:

The purpose of this evaluation is to determine the allowable radioactivity in TENORM that is disposed in a municipal or residual landfill.

2.0 Results:

TENORM inputs to a landfill will not exceed public dose limits if the amount is limited to 2 % of the total input and contact dose rate on the roll-off containers is limited to 30 uR/hr.

3.0 Methodology:

The methodology used is to use conservative inputs for TENORM parameters and landfill conditions and calculate dose to a hypothetical member of the public who is living on the landfill. The concentrations are then reduced to lower personnel dose rates and the dose rate on the incoming truck is calculated. Controlling inputs such as volume and dose rate on the incoming waste will be used as limits for acceptance of this waste in landfills.

4.0 References:

4.1 Radiological Risk Assessment for Disposal of Zircon Material in a Municipal Waste Landfill, RAE-9507/1-2, D. E. Bernhardt and V. Rogers, 1/2000

4.2 Data Collection Handbook to Support Modeling the Impacts of Radiological Material in Soil, ANL/EAIS-8, Argonne National Laboratory, 4/1993

4.3 Memo from D. E. Bernhardt to T. Hill (CRCPD TENORM), Subject: Information Concerning Zircon Materials, 10/2000

4.4 Radiological Dose Assessment Related to Management of Naturally Occurring Radioactive Materials Generated by the Petroleum Industry, ANL/EAD-2, Argonne National Laboratory, 9/1996

5.0 Assumptions:

Why is this assumed?

5.1 The TENORM is homogeneously mixed with other waste in the landfill. This is done because the inputs are all dumped together. Per discussion with Solid Waste

Management personnel, there is also considerable mixing in a landfill caused by decomposition and gas movement. It is recognized that concentrating the TENORM in a central location may produce a more conservative dose estimate but mixing is viewed as more realistic. Due to potential mixing of waste into the landfill cap, the cap is assumed non-existent.

5.2 The landfill is constructed per Pennsylvania regulations; inputs for the landfill sub-base are used. Synthetic membranes are not considered due to the potential for failure of these membranes during the 1000-year evaluation period.

5.3 Per discussion with Solid Waste Management personnel, a landfill site in Pennsylvania ranges up to 500 acres and 350 feet deep, use these dimensions in the RESRAD evaluations.

5.4 The waste is brought to the landfill in 20-yd3 roll-off containers. The dimensions of these containers vary, dimensions of 8' x 4' x 16' are used. Based on a discussion with RBS Enterprises, Inc. a roll-off vender in West Chester, 20-gage (0.1094") steel is used for the container wall.

6.0 Inputs:

6.1 The RESRAD, version 6.2 program is used to calculate personnel dose due to occupancy by a hypothetical resident.

6.2 The Microshield, version 5.05 program is used to calculate dose rates on the roll-off container.

6.3 Hypothetical resident dose rates from all inputs to the landfill will be limited to 25 mrem/yr (including indoor radon). The dose rate due to this blanket authorization will be limited to 20 mrem/yr (including indoor radon) so that future activities at the landfill are not unnecessarily limited.

6.4 The TENORM is assumed to be a small fraction of the total input to the landfill. 1 load in 50 is used in this evaluation.

7.0 Calculation:

7.1 Table 1 shows available radon diffusion/emanation data and distribution coefficients for TENORM materials. The numbers shown in Bold are used for this evaluation. The default radon diffusion coefficient is used.

a. The oil scale radon emanation coefficients are used.

b. The emanation factors conservative for TENORM materials, they are not conservative for typical sand. This sand value was not used by CRCPD for their zircon evaluation (Reference 4.1) because their consultant determined the sand values to be non-representative.

c. Distribution Coefficients were chosen based on the type material in the zone.

- Defaults were used for the Contaminated zone due to various types of materials contained. Default values are representative of soil.
- Unsaturated Zone 1 represents the 8-foot minimum distance between the landfill sub-base and the water table. Default values were used for this area.

- Unsaturated Zone 2 represents the sub-base, a 6"clay layer. Coefficients specific to clay were used for this region.
- The secondary liner is not considered.
- Unsaturated Zone 3 represents the 12" leachate detection zone. This zone is engineered to draw leaked leachate into a collection pond. Coefficients specific to sand were chosen to represent this area.
- The primary liner is not considered.
- Unsaturated Zone 4 represents the 24" liner protective cover. This zone uses clean soil; default values were used for this zone.
- Default values were use for the Saturated Zone. This is the region that contains the water table below the landfill.

7.2 Table 2 shows non-radiological inputs used for the evaluation.

a. Zone thickness' was determined as described above.
b. Attributes for Unsaturated Zone 1 are based default values.
c. Attributes for Unsaturated Zone 2 are based on clay values.
d. Attributes for Unsaturated Zone 3 are based on sand values.
e. Attributes for Unsaturated Zone 4 are based on default values.
f. The landfill cap thickness uses the default value of 0 meters. This is done to account for potential mixing of the waste into the cap. The landfill experiences significant mixing due to decay induced action within the landfill.
g. The landfill area is assumed to be 500 acres. Typically landfills are in the 200-500 acres range.
h. Contaminated Zone thickness is assumed to be 350 feet. Typically landfills are less than 300 feet thick.
i. The Contaminated Zone is assumed to erode at a lower rate than normal. This is due to cap erosion controls in place in the landfill such as sloping and planting. The material in the landfill is also compacted during placement.

7.3 Table 3 shows the results of the RESRAD and Microshield evaluations. The initial radionuclide concentrations used are from Reference 4.1. These concentrations are assumed to be diluted in the landfill; a 50:1 dilution is used. The resulting annual dose to a hypothetical resident is 28.86 mrem at 1000 years. The RESRAD output is graphed in Figure 1, the complete output is provided in Attachment 1.

7.4 The radionuclide concentrations were then reduced to reduce the maximum hypothetical dose to 20 mrem/yr. This output is graphed in Figure 2 and shown in Attachment 2.

7.5 The acceptable landfill concentration is increased by a factor of 50 and converted to uCi/cm3. This is done to obtain the radionuclide concentration in the roll-off container prior to dilution in the landfill. This concentration is modeled using Microshield to obtain the expected dose rate on the truck.

TABLE 1
TENORM RESRAD INPUTS

PARAMETER	DEFAULT	ZIRCON	ref	SAND	ref	OIL SCALE	ref	CLAY	ref
Rn Diffusion Coefficient	**2.00e-6**			1.90e-7	4.2				
Rn-222 Emanation Coefficient	0.25	.008-.014	4.3	.14	4.2	**.05**	4.4		
Rn-220 Emanation Coefficient	0.15	.008-.014	4.3			**.05**	4.4		
Distribution Coefficients (Kds):	(used for unsat. zones 1&4 and sat. zone)			(used for unsat. zone 3)				(used for unsat. zone 2)	
Actinium	**20**			**450**	4.2			**2400**	4.2
Protactinium	**50**			**550**	4.2			**2700**	4.2
Lead	**100**	100,000	4.1	**220**	4.2			**550**	4.2
Radium	**70**	3,000-10,000	4.1	**500**	4.2			**9100**	4.2
Thorium	**60,000**	60,000	4.1	**3,200**	4.2			**5800**	4.2
Uranium	**50**	10,000	4.1	**35**	4.2			**1600**	4.2

Note; Bold values are used in this evaluation

TABLE 2
LANDFILL RESRAD INPUTS

PARAMETER	DEFAULT	VALUE USED	BASIS
Unsaturated Zone Thickness	4 m total	3.505 m total	
Unsaturated Zone Thickness (1)	Included in above	2.438 m	Reference 25 PaCODE 273.252.b & 288.4332.b minimum distance from sub-base to water table
Unsaturated Zone Thickness (2)	Included in above	0.152 m	Reference 25 PaCODE 273.b.1 & 288.b.1, clay sub-base layer
Unsaturated Zone Thickness (3)	Included in above	0.305 m	Reference 25 PaCODE 273.255.b.1 & 288.435.b.4, leachate detection zone thickness
Unsaturated Zone Thickness (4)	Included in above	0.610 m	Reference 25 PaCODE 273.257.b.3 & 288.437.b.4, liner cover thickness
Unsaturated Zone (2) Attributes			
total porosity	0.4	0.42	Based on reference 4.2 value for clay
eff. Porosity	0.2	0.06	Based on reference 4.2 value for clay
hydraulic conductivity	10	40.5	Based on reference 4.2 value for clay
b parameter	5.3	11.4	Based on reference 4.2 value for clay
density	1.5	1.2	Based on reference 4.2 value for clay
Unsaturated Zone (3) Attributes			
total porosity	0.4	0.39	Based on reference 4.2 value for sand
eff. porosity	0.2	0.3	Based on reference 4.2 value for sand
Hydraulic conductivity	10	1600	Based on reference 4.2 value for sand
b parameter	5.3	4.05	Based on reference 4.2 value for sand
Cap Thickness	0 m	0 m	Reference 25 PaCODE 273.233.c.1.1, 234.a.3 & 288.233.d.1, 234.f.4 requires a cap but no cap is used to account for decay induced mixing in the landfill
Landfill Area	1.00e+4 m2	2.02e+6 m2	Assume 500 acre area
Length Parallel to Aquifer Flow	100 m	1422 m	Assume the 500 acre area is square, this is the length of one side
Contaminated Zone Thickness	2 m	106.7 m	Assume 350 foot thickness

Contaminated Zone Density	1.5 g/cm3	1.5 g/cm3	
Building Depth Below Ground Surface	-1 m	2 m	Assume building has basement
Contaminated Zone Erosion Rate	1.00e-3	1.00e-4	Assume lower values due to cap erosion controls required in 25 PaCODE 273.192.b.4.v & 288.182.b.4.v on cap and compaction of waste in the landfill

TABLE 3
ISOTOPIC MIX AND CONCENTRATIONS USED

ISOTOPE	REF 4.1 pCi/g	Landfill pCi/g, 50:1 Dilution	Landfill pCi/g 50:1 Dilution and 20 mrem/yr max dose	Roll-off Container 50:1 Concentration in uCi/cm3
U-238	30	0.6	0.267	2.00e-5
Th-234	30	0.6	0.267	2.00e-5
U-234	30	0.6	0.267	2.00e-5
Th-230	30	0.6	0.267	2.00e-5
Ra-226	30	0.6	0.267	2.00e-5
Rn-222	30	0.6	0.267	2.00e-5
Po-218	30	0.6	0.267	2.00e-5
Pb-214	30	0.6	0.267	2.00e-5
Bi-214	30	0.6	0.267	2.00e-5
Po-214	30	0.6	0.267	2.00e-5
Pb-210	30	0.6	0.267	2.00e-5
Bi-210	30	0.6	0.267	2.00e-5
Po-210	30	0.6	0.267	2.00e-5
Th-232	5	0.1	0.0445	3.34e-6
Ra-228	5	0.1	0.0445	3.34e-6
Ac-228	5	0.1	0.0445	3.34e-6
Th-228	5	0.1	0.0445	3.34e-6
Ra-224	5	0.1	0.0445	3.34e-6
Rn-220	5	0.1	0.0445	3.34e-6
Po-216	5	0.1	0.0445	3.34e-6
Pb-212	5	0.1	0.0445	3.34e-6
Bi-212	5	0.1	0.0445	3.34e-6
Po-212	5	0.1	0.0445	3.34e-6
Tl-208	5	0.1	0.0445	3.34e-6
U-235	1.5	0.03	0.0133	9.98e-7
Th-231	1.5	0.03	0.0133	9.98e-7
Pa-231	1.5	0.03	0.0133	9.98e-7
Ac-227	1.5	0.03	0.0133	9.98e-7
Th-227	1.5	0.03	0.0133	9.98e-7
Ra-223	1.5	0.03	0.0133	9.98e-7
Rn-219	1.5	0.03	0.0133	9.98e-7
Po-215	1.5	0.03	0.0133	9.98e-7
Pb-211	1.5	0.03	0.0133	9.98e-7
Bi-211	1.5	0.03	0.0133	9.98e-7
Tl-207	1.5	0.03	0.0133	9.98e-7
Calculated Dose Rate		44.95 mrem/yr max	20.00 mrem/yr max	33.52 uR/hr at 2" from roll-off

Figure 1

RESRAD Output
2% of Landfill Input
is TENORM at 30 pCi/g U-238

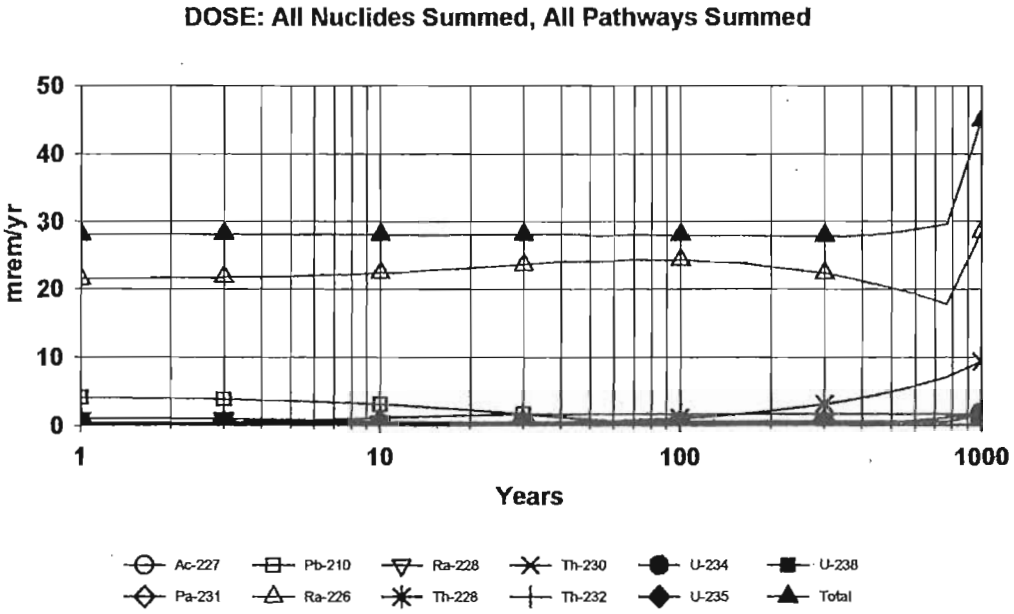
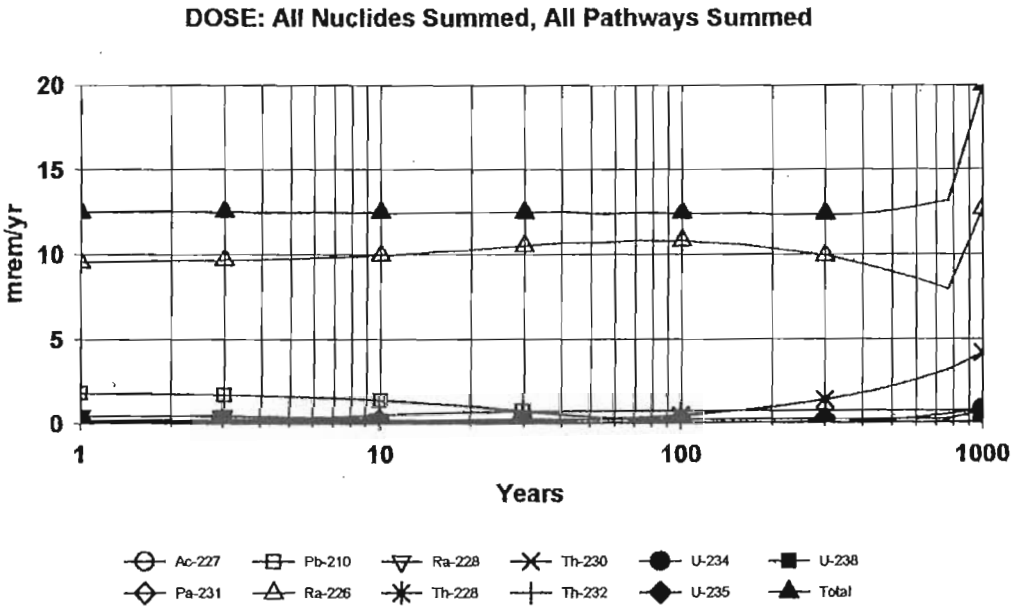


Figure 2

RESRAD Output
2% of Landfill Input
is TENORM at 33.52 uR/hr



4/28/2014

DRAFT - Pennsylvania Landfill TENORM Acceptance

The following list represents the Pennsylvania Landfills that have accepted TENORM-containing waste between January 1, 2012 and February 28, 2014:

1. Southern Alleghenies Landfill
2. Arden Landfill
3. Tervita Sanitary Landfill
4. Valley Landfill
5. Lake View Landfill
6. McKean County Landfill
7. Seneca Landfill
8. Chestnut Valley Landfill
9. Evergreen Landfill
10. Northwest Sanitary Landfill
11. South Hills Landfill
12. Monroeville Landfill
13. Imperial Landfill
14. Kelly Run Sanitation Landfill
15. Alliance Sanitary Landfill
16. Greentree Landfill
17. Shade Landfill
18. Tullytown Landfill
19. Laurel Highland Landfill
20. Mostoller Landfill
21. GROWS North Landfill
22. White Pines Landfill
23. Phoenix Resources