

Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM)

New Requirements at Landfills



MICHIGAN DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY

2018 TENORM Laws

P.A. 688 & 689

P.A. 688 and 689 were enacted as tie barred senate bills (S.B. 1196 and 1195) and were signed into law 12/31/18, effective 3/28/2019:

- P.A. 689:
 - Sets tipping fee for TENORM disposal at hazardous waste landfills
- P.A. 688:
 - Defines TENORM in statute
 - Sets disposal limits on TENORM concentrations in landfills
 - Creates environmental and occupational health monitoring requirements for landfills that accept TENORM

What is TENORM ?

- “TENORM” means Technologically Enhanced Naturally Occurring Radioactive Material. This is material that occurs in nature whose radionuclide concentrations have been increased through human activity.
- Industries that process a lot of water are typically sources of TENORM waste, such as:
 - Oil and Gas production
 - Municipal drinking and waste water treatment
 - Copper mining and production

*An Assessment of the Disposal of Petroleum
Industry NORM in Nonhazardous Landfills*

National Petroleum Technology Office, US DOE
DOE/BC/W-31-109-ENG-38-8
October 1999

In 1999, DOE published, “An Assessment of the Disposal of Petroleum Industry NORM in Nonhazardous Landfills”. The document used landfill computer codes for movement of radium within the landfill and through the environment, and used TSD-DOSE and RESRAD to calculate radiation doses to landfill employees and members of the public.

The study assumed that 2,000 m³ of waste having concentrations of Ra-226 at 50 pCi/g and Ra-228 at 12.5 pCi/g disposed in a nonhazardous landfill. The Pb-210 calculation assumed 20 m³ of material with a concentration of 260 pCi/g of Pb-210. The material was buried at least 10 feet below the landfill cap.

Conclusions

Assumes 2,000 cubic meters of soil with 50 pCi/g Ra-226:

- Potential radiological doses and health risks negligible for workers
- Potential dose to individual next to landfill during disposal negligible
- Potential doses to public living with 50 miles negligible
- Potential doses to future industrial and recreational users of site negligible

If the material is placed at least 10 feet below the landfill cap and the cap is not breached during construction, the potential dose to a residential user is negligible

TABLE 7 Estimated Peak-Year Dose and Carcinogenic Risks for Disposal of NORM-Impacted Wastes in a Nonhazardous Landfill

Receptor	Radium-Bearing NORM ^a		Lead-210 NORM ^b	
	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk
<i>Operational phase scenarios</i>				
Driver	0.3	1×10^{-7}	0	0
Waste-placement operator	1.7	7×10^{-7}	2.4×10^{-6}	9×10^{-13}
Leachate worker	2×10^{-4}	8×10^{-11}	0	0
Off-site resident	6.6×10^{-4}	3×10^{-10}	3.3×10^{-6}	2×10^{-12}
General population ^c (50-mi radius)	2.7×10^{-5}	1×10^{-8}	1.3×10^{-7}	7×10^{-11}
<i>Future use scenarios</i>				
On-site resident	7.4	4×10^{-6}	0	0
On-site industrial worker	2.2	1×10^{-6}	0	0
Recreational visitor	1.2×10^{-7}	6×10^{-14}	0	0
Off-site resident	3.2×10^{-4}	2×10^{-10}	0	0

^a Doses are for bulk disposal of 2,000 m³ of radium-bearing wastes having an average Ra-226 concentration of 50 pCi/g.

^b Doses are for bulk disposal of one truckload (20 m³) of lead-bearing wastes having an average Pb-210 concentration of 260 pCi/g.

^c Dose for the general population is in person-rem.

P.A. 688 TENORM definition

- “TENORM” means naturally occurring radioactive material whose radionuclide concentrations have been increased as a result of human practices. TENORM does not include any of the following material:
 - Source material, as defined in section 11 of atomic energy act of 1954, 42 U.S.C. 2014, and its progeny in equilibrium.
 - Material with concentrations of radium-226, radium-228 and lead-210 each less than 5 picocuries per gram (pCi/g).

Uranium and Thorium

The U.S. Nuclear Regulatory Commission, Agreement States, and Michigan's "Ionizing Radiation Rules" have this definition:

10 CFR 40.4 Definitions. (excerpt)

Source Material means:

- (1) Uranium or thorium, or any combination thereof, in any physical or chemical form or
- (2) ores which contain by weight one-twentieth of one percent (0.05%) or more of: (i) Uranium, (ii) thorium or (iii) any combination thereof. Source material does not include special nuclear material.

P.A. 688 amendments to Parts 115 and 111

- Sets upper limits on the concentrations of TENORM radionuclides landfills may accept:
 - Ra-226 and Ra-228 limited to 50 pCi/g
 - Pb-210 limited to 260 pCi/g
- Requires that TENORM accepted for disposal be characterized for:
 - Radionuclide concentrations
 - Total radioactivity and mass of the shipment
 - Date of delivery

Part 115 amendments (Type II Landfills)

- All operators must submit a summary of TENORM waste received during the previous fiscal year
- Type II landfills accepting TENORM waste at greater than 25 pCi/g Ra-226, Ra-228, or Pb-210 subject to additional monitoring requirements
- Type II landfills may accept waste at concentrations below 25 pCi/g without enhanced monitoring requirements

Additional Requirements waste >25 pCi/g (Type II landfills)

- Ensure TENORM is deposited 10 feet below bottom of the future landfill cap
- Maintain records of the location and elevation of TENORM disposed
- Conduct radiological monitoring of workers
- Conduct radiological monitoring at the landfill property boundary
- The hydrogeological monitoring plan must include testing for radium-226, radium-228, and lead-210
- Results of all monitoring required shall be included in the environmental monitoring reports per the facility operating license

Part 111 amendments (Type I Landfills)

- All operators must submit a summary of TENORM waste received during the previous fiscal year
- Type I landfills accepting any TENORM waste are subject to additional monitoring requirements

Additional Requirements (Type I Landfills)

- Ensure TENORM is deposited 10 feet below bottom of the future landfill cap
- Maintain records of the location and elevation of TENORM disposed
- Conduct radiological monitoring of workers
- Conduct radiological monitoring at the landfill property boundary
- The hydrogeological monitoring plan must include testing for radium-226, radium-228, and lead-210
- Results of all monitoring required shall be included in the environmental monitoring reports per the facility operating license

Part 111 Increased Limits (Type I Landfills)

P.A. 688 allows a Type I landfill to apply for a major modification to their operating license to accept higher concentrations of TENORM.

Part 111 Increased Limits (cont.)

The modification would be limited to:

- Maximum accepted concentration of 500 pCi/g of each radionuclide
- Modelling (such as RESRAD) demonstrating the maximum annual public would be 25 millirems in perpetuity
- Approval of such a major mod would constitute a license from the Radiological Protection Section, including comprehensive radiation protection plan

Questions?

Links

[Michigan's Ionizing Radiation Rules](http://www.michigan.gov/deq/0,4561,7-135-3312_4120_4244-10069--,00.html)

www.michigan.gov/deq/0,4561,7-135-3312_4120_4244-10069--,00.html

[EQC-1602 Cleanup and Disposal Guidelines for Sites Contaminated with Radium-226](http://www.michigan.gov/deq/0,4561,7-135-3312_4120_4244-10128--,00.html)

www.michigan.gov/deq/0,4561,7-135-3312_4120_4244-10128--,00.html

[TENORM Disposal Advisory Panel White Paper](http://www.michigan.gov/documents/deq/deq-RMG-TENORM_Disposal_Advisory_Panel_White_Paper_-_FINAL_481404_7.pdf)

www.michigan.gov/documents/deq/deq-RMG-TENORM_Disposal_Advisory_Panel_White_Paper_-_FINAL_481404_7.pdf

[DOE An Assessment of the Disposal of Petroleum Industry NORM in Nonhazardous Landfills](http://www.osti.gov/scitech/servlets/purl/13061/)

www.osti.gov/scitech/servlets/purl/13061/

[NCRP Report 160 Ionizing Radiation Exposure of the Population of the U.S. - Pie Charts](http://ncrponline.org/publications/reports/ncrp-report-160-pie-charts/)

ncrponline.org/publications/reports/ncrp-report-160-pie-charts/

[U.S. Nuclear Regulatory Commission website](http://www.nrc.gov)

www.nrc.gov

[Pennsylvania: Radioactive Material at Solid Waste Landfills website](http://www.dep.pa.gov/Business/RadiationProtection/RadiationControl/Radioactive-Material-In-Solid-Waste-Monitoring/Pages/default.aspx#.Vu_ws6PD-Dg)

www.dep.pa.gov/Business/RadiationProtection/RadiationControl/Radioactive-Material-In-Solid-Waste-Monitoring/Pages/default.aspx#.Vu_ws6PD-Dg



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