



Department of Health  
and Environment  
*Division of Public Health*

# NATURALLY OCCURRING RADIOACTIVE MATERIAL

Kansas Department of Health and Environment  
Radiation Control Program  
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## INTRODUCTION

Naturally occurring radioactive material (NORM) can concentrate as the result of human activities such as oil and gas operations, mining, water treatment, etc. This material, when technologically enhanced (TE), can present serious health and safety hazards if it is not handled and disposed of properly. TENORM associated with uranium, thorium, and their associated decay products is of the greatest concern. In Kansas, the most common problem associated with TENORM is oil and gas field pipe removed from the ground that is recycled as scrap metal. The pipes are lined with scale that contains small quantities of radium-226 ( $^{226}\text{Ra}$ ). Some pipes contain enough radium to alarm radiation detectors at scrap yards and steel mills.

TENORM responses are evaluated to decide if a radioactive materials license is required for possession of the material. There is currently no satisfactory cost-effective way of disposing of this material. Waste brokers, will dispose of the material according to existing waste regulations. Regulations for the separate and specific control of TENORM have not been finalized. Regulations for the control of all radioactive material in Kansas implicitly include TENORM. TENORM problems that do arise are handled on a case by case basis considering exposure to the public and worker.

## DEFINITIONS

**Background radiation** (from KRPR 28-35-135b, 2006)

“Background radiation” means:

- Radiation from cosmic sources;
- Naturally occurring radioactive materials, including radon, except for those radioactive materials that are a decay product of source material or special nuclear material; and
- Global fallout as it exists in the environment from the testing of nuclear explosive devices.

The term “background radiation” shall not include sources of radiation from radioactive materials regulated by the department.

**Technologically Enhanced Naturally Occurring Radioactive Material** (Kansas Statute Annotated (K.S.A.) 48-1603(z))

Technologically enhanced NORM" or "TENORM" means NORM whose radionuclide concentrations are increased by or as a result of past or present human practices. "TENORM" does not include accelerator produced, by-product, source or special nuclear material.

## TENORM IN SCRAP METAL

In Kansas, scrap metal recyclers have been the most common industry affected by TENORM. Shipments of scrap metal material rejected by receiving facilities due to unacceptable radiation levels are sent back to the owner of the shipment. KDHE is primarily concerned with ensuring that the shipment does not contain other radiation sources that may have been lost by a licensee or stolen from a licensee and that may pose a significant health hazard.

When a shipment has been rejected from a receiving facility, the original shipper personnel are directed to inform the Radiation Control Program when the shipment arrives back on their property. They are also directed to remove the radioactive material and retain it in their custody. The Radiation Control Program is to be informed if:

- A scale-filled or sludge-filled pipe, valve, pump, or tank that shows a radiation reading  $> 1$  mR/h (1,000  $\mu$ R/h) on contact (within 0.5 inches), or
- Any object not recognized as a component from the oil or gas industry that shows a contact radiation reading  $> 0.01$  mR/h (10  $\mu$ R/h) above the reference background.

It is recommended that personnel measure the reference background radiation levels in an area away from any scrap metal storage areas or areas where pipe cutting operations are done. Average background radiation in Kansas is 12-14  $\mu$ R/h but can vary significantly due to location and instrumentation used. It is also recommended that they segregate and store the material in a designated area at their facility that is away from normal traffic routes. Containers for the material should be labeled or marked so workers will not place them in another outgoing shipment. A label such as NORM SCRAP is sufficient.

**Table 1.0** NORM regulations in oil and gas production (adapted from information provided for a survey conducted by the Interstate oil and gas compact commission).

State	Kansas
Regulating Agency	Radiation Control Program, Bureau of Community Health Systems, Kansas Department of Health and Environment.
Relevant statute/regulations	There are no existing or proposed regulations specific to NORM.
Scope	The State of Kansas Radiation Protection Regulations apply to all persons who receive, possess, use, transfer, own or acquire any source of radiation.
Licensing	NORM responses are evaluated to decide if radioactive materials license is required for the material.
Cleaning equipment	Descaling or cleaning operations would require a Radioactive Materials License if scale or sludge contains significant quantities of radioactive material, such as <sup>226</sup> Ra.
Disposal of waste	A number of waste broker and processor services are available-a list has been compiled by the Conference of Radiation Control Program Directors, Inc. (CRCPD).
Subsequent use of equipment	Release criterion of contaminated equipment would fall under the scope of Kansas Radiation Protection Regulations. Specific requirements would be addressed depending upon the scope of the licensee's proposed activities.
Subsequent use of materials	Release criterion of contaminated materials would fall under the scope of Kansas Radiation Protection Regulations. Specific requirements would be addressed depending upon the scope of the licensee's proposed activities.
Release/Sale of NORM-contaminated land	A radioactive materials license would be required and appropriately transferred to the new owners.
Projected volume of stored NORM in the state	The extent of NORM contamination in oil and gas operations in Kansas has not been assessed.

**TABLE 2.0** Industrial TENORM contamination (from EPA ANR-460, *Diffuse NORM Waste Characterization and Preliminary Risk Assessment*, May 1991). <sup>a</sup>

Description	Average annual inventory 10 <sup>7</sup> kg/y <sup>b</sup>	Average <sup>226</sup> Ra concentration 10 <sup>3</sup> pCi/kg <sup>c</sup>	<sup>226</sup> Ra activity per year Ci/y
Uranium mining, overburden	3,700	24	877
Phosphate waste:			
Phosphogypsum	4,000		
Slag	300	33	1,320
Scale	* <sup>d</sup>	35	105
		1,000	*
Phosphate fertilizers	500	8	41
Coal waste:			
Fly ash			
Bottom ash and slag	7,500	4	293
	2,600	3	81
Petroleum production scale and sludge	42	155	64
Drinking water treatment:			
Sludges	26	16	4
	4	35,000	1,470
Radium selective resins			
Mineral processing	100,000	35	35,000
Geothermal Wastes	7	160	11

<sup>a</sup> Adapted from Table ES-1, p. ES-3. The emphasis of this document is on TENORM that contains uranium, thorium, and their associated decay series.

<sup>b</sup> 10<sup>3</sup> kg = 1 metric ton (1.1 short ton).

<sup>c</sup> Note that 10<sup>3</sup> pCi/kg = 1 pCi/g. A rough estimate of the external dose rate may be made by using the conversion factor of 1 μR/h above background per 1 to 5 pCi/g <sup>226</sup>Ra (this conversion factor was determined for petroleum production scales and sludges). The radium concentrations in this table are average values-maximum values could be as high as 100,000 pCi/g for some waste streams (from CRCPD Part N rationale, 1997). Soil samples in Kansas typically contain 1 to 4 pCi/g of <sup>226</sup>Ra.

<sup>d</sup> 3,000 m<sup>3</sup>.

**TABLE 3.0** Typical rules adopted by some States used to set exemptions for TENORM contaminated equipment (from The NORM Report, Winter 97). The State of Kansas has not adopted these rules at this time.

Concentration limit in soil pCi/g	Gamma exposure rate μR/h	Loose surface contamination cpm
(1) 5 pCi/g to 30 pCi/g	(1) 25 μR/h > background	100 cpm > background per 100 cm <sup>2</sup>
<p>Dependent upon the radon emanation rate from the soil. If the Radon emanation rate is &lt; 20 pCi/ m<sup>2</sup>-s, the upper soil concentration limit may be used. The CRCPD proposed limit is 5 pCi/g.</p> <p>Soil samples are averaged over any 100 m<sup>2</sup> and averaged over the first 15 cm of soil below the surface.</p>	<p>(2) 50 μR/h including background</p> <p>(3) Total Effective Dose Equivalent (TEDE) not to exceed 15 to 100 mrem/y. The CRCPD proposed limit is 100 mrem/y TEDE.</p>	<p>Using an efficiency of 10 %, this would correspond to 1000 dpm per 100 cm<sup>2</sup> (the CRCPD recommended limit for alpha or beta+gamma).</p>