TENORM Radiation Safety
From Oil and Gas Production

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Just To Be Clear

- We’re talking about this NORM:

- Not talking about this Norm:

  Corner stool at Cheers; loves beer
Outline

- Definitions
- Sources and types of NORM/TENORM
- NORM/TENORM Regulations
- TENORM Radiation Safety
NORM: Naturally Occurring Radioactive Material – U, Th, Ra, Rn, Po

- We live on a radioactive planet
- Radioactivity is found everywhere
  - Soil
  - Rock
  - Plant
  - Animal
- We are exposed 24/7
TENORM – Technologically Enhanced NORM

Natural material whose radioactive concentrations have been enhanced by human activities including:

- Oil & gas pipe scale
- Oil & gas sludges
- Water treatment filter media
- Natural gas processing equipment
Ionizing Radiation – Why Worry?

- Ionizing radiation health risks:
  - Acute effects – high levels of radiation produce effects such as blood chemistry changes, nausea, fatigue, various skin effects, cataracts, and death
  - Delayed effects – at some lower level of radiation, can increase risk of some cancers

- Radiation is a weak carcinogen compared to other materials (beryllium, asbestos, tobacco smoke...)

- What about at typical environmental and occupational dose levels? No risk? Hormesis? What are the implications?
**TENORM Exposure Pathways**

- Radon gas, external exposure, internal exposure
- Potential:
  - Worker exposure
  - General public exposure (and associated litigation risks)
  - Environmental impact
Oil & Gas Industry

- NORM/TENORM present in all phases
- Concentrations depend on geology
  - Higher concentrations in production phase (scale/sludge)
  - Drill cuttings
  - Produced water/flowback water
  - Radon decay products in gas production equipment
Which Regulations Govern My Operation?

- Some Federal regulations ‘touch’ on NORM
  - EPA
  - OSHA
  - DOT
- It really boils down to what State(s) do I operate in
Regulations Overview

- **EPA** – sets federal radiation standards for the public
- **OSHA** – has authority over hazardous materials in the workplace
- **DOT** – transportation of hazardous materials, including radioactivity, such as NORM

**States**
- NORM-specific regulations
- Workplace dose rates; concentration limits in soil
- Waste management
Federal Agencies - EPA

- Airborne releases from phosphate industry and uranium mines under CAA
- Liquid discharges of TENORM from U mines and mills under CWA
- Superfund site cleanups
- Office of Water published proposed pretreatment standards prohibiting discharges of unconventional O&G extraction wastewater to publically owned wastewater treatment plants – April 7, 2015
Federal Agencies - OSHA

- The regulator when workers are not covered under a materials license and are not Federal employees
  - Why? Because radiation is defined as a workplace hazard under OSHA regulations
  - The Reality – not actively regulating this or any radiation hazards
Generators have the responsibility to know about their waste and appropriate management.

Waste characterization:
- Can be done through analytical testing, or
- Through generator knowledge of a waste based on defensible and demonstrated factors
- If uncertain, generators have the responsibility to perform analytical testing.
## Oil Field Waste: Example Radionuclide Content

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Average Sludge pCi/g*</th>
<th>Average Scale pCi/g*</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{210}$Po</td>
<td>56</td>
<td>360</td>
</tr>
<tr>
<td>$^{210}$Pb</td>
<td>56</td>
<td>360</td>
</tr>
<tr>
<td>$^{226}$Ra</td>
<td>56</td>
<td>360</td>
</tr>
<tr>
<td>$^{228}$Th</td>
<td>19</td>
<td>120</td>
</tr>
<tr>
<td>$^{228}$Ra</td>
<td>19</td>
<td>120</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>206</strong></td>
<td><strong>1,320</strong></td>
</tr>
</tbody>
</table>

270 pCi/g Ra-226, Ra-228 subject to DOT regulation. Typical background radium-226 in soil is ~1 pCi/g

* EPA Data
16 states have regulations covering TENORM
Another 9 have regulations and/or guidance addressing NORM
CRCPD Part N suggested TENORM regulations
Check your State regs!

States
Some Common Threads In Determining If Exempt

- More robust regulatory programs in traditional oil producing States across the south; much less so in the newer gas regions
- 50 µR/h (sometimes including background, sometimes not) from surface of equipment
- 5 pCi/g radium (usually above background); not easy to determine with hand-held instrument
Do We Need A License?

- It depends on
  - What State you’re in
  - What you do
Where To Send Waste For Disposal

- Some waste acceptance criteria examples (5 states have landfills that can accept > 50 pCi/g)

- Texas:
  - Radium-226: 30 pCi/g
  - Pb-210: 150 pCi/g
  - Equipment: <50 µR/hr

- Idaho:
  - Radium (Ra-226 + Ra-228)
  - Bulk: 500 pCi/g
  - IP-1 package: 1,500 pCi/g

- Michigan:
  - Radium-226: 50 pCi/g
  - Pb-210: 260 pCi/g

- Washington:
  - Radium-226: 10,000 pCi/g
  - Pb-210: no upper limit
What About Injection Well Disposal For O&G NORM Wastewater?

- Maybe
- Injection wells in Ohio, Louisiana, Texas, Alaska, N.D.
- Elsewhere – wastewater treatment plant followed by landfill disposal of filter cake
Oilfield NORM/TENORM – Workers Exposed?

- Maintenance personnel – cutting, grinding, welding, scraping, dismantling pipes (scale/sludge)
- Pipe/equipment recyclers
- Personnel involved in remediation and decontamination operations
- Waste handlers/transporters
Oilfield NORM/TENORM – Who Else Could be Exposed?

- Members of the public
  - Landowners who have leased mineral rights
  - Transportation of wastes containing radioactive materials
  - Water treatment plant workers – they are members of the public with respect to radiation regulations

- Legal Implications?
TENORM Radiation Safety

- Written Radiation Safety Protocols
- Training
- Survey Activities:
  - Instrument surveys for dose rate, contamination
  - Air monitoring?
  - PPE – air filter, gloves, other
Dose Monitoring

Record-keeping – if there’s no record, then it wasn’t done

- Can you defend your program if challenged?
- We live in a very litigious society so this can’t be stressed enough
Common Sense Radiation Safety In An Uneven Regulatory Environment

- Be familiar with your State’s regulations
- Develop radiation safety procedures
- Provide radiation safety training
- Generate and maintain radiation safety records, including dosimetry
- KEEP IT REAL!!!
Questions?

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