NORM IX Symposium

Status Report on the NCRP
Commentary on NORM/TENORM
From the Oil & Gas Industry in the United States

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• National Council on Radiation Protection and Measurements
  – Founded in 1928 as the U.S. Advisory Committee on x-ray and Radium Protection
  – Chartered by Congress in 1964 as NCRP
  – Provides Science-Based National Radiation Protection Recommendations
  – Established Scientific Committee (SC) 5-2
Part 1: Develop a Commentary to provide an overview of the generation/disposal of TENORM from oil & gas production and recommendations for a full NCRP report.

Part 2: Develop a full NCRP report providing radiation protection recommendations for states, workers, the public, and the environment.
Focus on the Oil & Gas Industry in the U.S.

- It is recognized that NORM/TENORM are generated by numerous industries (mining, mineral extraction, geothermal, ceramics, phosphate production, water treatment, and more)

- Scope limited to oil & gas production since wastes from these technologies pose public health challenges across the U.S. – may be similar for other NORM/TENORM
SC 5-2 Commentary
Contents

- Origins of NORM (natural background 101)
- Overview of oil & gas operations that generate NORM/ TENORM
- Current waste management options
- Other factors (fear) affecting safety
- Historic/current U.S. regulatory framework
- Disposal modeling considerations
- Legal Considerations
NORM/TENORM Issues

- Uranium/radium in geologic formations known and measured since ~1900
- 1980s – Radium pipe scale
  - Radium preferentially soluble in saline
  - Precipitates with barium, calcium, and minerals as pipe scale or heavy sludge
  - Pipe recycling issues
  - Waste disposal issues
Pipe Scale
Oil & Gas Operations

- Conventional geology and drilling methods
  - Vertical well to trapped resources
  - Limited remaining resources in the U.S.
- Unconventional geology and drilling
  - Impermeable, deep rock formations (shale)
  - Oil & Gas “bound” by rock (doesn’t flow and difficult to produce)
  - Conventional drilling doesn’t work (slow or no recovery)
Unconventional Methods

• Hydraulic fracturing
  – Use of hydraulic pressure to fracture shale
  – Fractures allow oil & gas to flow for recovery

• Horizontal drilling
  – Allows for lengthy (up to ~ 2 km) horizontal wells in shale formations
  – Numerous horizontal wells from a single vertical well greatly expands the well footprint
Conventional vs Unconventional Wells
Shale Deposits (Plays)
Hydraulic Fracturing – A Brief History

- Technology began in 1857 – Preston Barrymore lowered black powder into oil wells – explosion stimulated production
- Process proved to be “unreliable”
- 1940s – Standolind oil used hydraulic pressure to fracture rock
- Quickly commercialized in the 1960s in Kansas/Oklahoma/Texas for conventional wells
A Brief History of Hydraulic Fracturing

• 1975 – President Ford promoted development of shale oil resources as part of his overall energy plan (reduce imports)

• 1990s – Modern day fracking, George P. Mitchell, combined fracking with horizontal drilling; greatly increased production

• Injection of fluids (water), sand, and/or chemicals below ground to the host rock under high pressure (10s of megaliters!)
In the 1970s-1980s, vertical well could be curved in a horizontal direction parallel to and within shale formations.

Allowed numerous extended lateral wells from a single vertical well to create a large well oil & gas recovery zone.

Newer methods (computerized seismic mapping) helps keep the horizontal well in the shale layer.
Staged Equipment
Drill Rig
Recovered Waste Water
Removal of a Gas Pipeline Pig
Solid Waste Options

- Hazardous Waste Landfill (RCRA)
- Low Level Radioactive Waste Landfill
- Onsite management (disposal onsite)
- Down-hole disposal
- Clearance/abandonment
- Land spreading
- Reuse/recycling (steel pipe/equipment)
Liquid Waste Options

- Deep well injection – only selected states
- Reuse as hydraulic fracturing fluid
- Effluent discharges – if EPA/state limits can be met
- Onsite treatment (filters/evaporators) – may create concentrated radium-bearing solids for disposal
Uniform Waste Management Strategy

- Waste management plans to identify and resolve issues
- Process knowledge to establish operational basis
- Sampling plans (strategies, methods, QA/QC, & records)
- Coordinated waste disposal methods (regulator and stakeholder involvement)
Worker fears of radiation – overly conservative decisions vs real risks

Is it safe – how do you know who to trust?

Radiation measurements unless by trained staff can be confusing or wrong (errors and uncertainties)

Role of training and communications to reduce fears and improve safety
EPA promulgates standards for NRC/DOE implementation

EPA has authority to regulate NORM radionuclides (air, water, and residuals)

However, EPA has no comprehensive NORM/TENORM regs

NORM/TENORM largely outside NRC/DOE authority
Role of the NCRP

• Protecting workers, the public, & environment
• Develop recommendations consistent with ICRP within the national context
• Mission: to provide national framework & recommendations radiation protection
• Provides the scientific basis for promulgating regulations
2018 Recommendations aligned with ICRP for planned, emergency, existing, and existing exposure situations

Five categories: occupational, public, medical, emergency, and non-human biota

Expanded discussions of justification, optimization, and numeric protection

Basis for updated national regulations
By U.S. regulatory framework, individual states regulate.

A nationwide, consistent framework lacks.

States regulate without much scientific or technical support, largely *ad hoc*.

Lack of consistent regulations means monitoring workers or the workplace is inconsistent, rare, or non-existent.
Uranium Mill Tailings Control Act (UMTRCA)

- Control/remediation of uranium and thorium mill tailings (land remediation)
- Covers abandoned facilities (legacy sites)
- Cleanup criteria for surface soils have been adopted as landfill disposal limits or exempt quantities
- It seems inappropriate that cleanup levels would also serve as disposal limits without justification
## Example State Regulations (Simplified)

<table>
<thead>
<tr>
<th>Waste Form</th>
<th>Radium Waste Acceptance Criteria or Exempt Quantity</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids</td>
<td>0.185 Bq/g (5 pCi/g)</td>
<td>Alabama, Arkansas, Georgia, Louisiana, Kentucky, Maine, Michigan, Mississippi, North Dakota, Ohio, South Carolina, Virginia,</td>
</tr>
<tr>
<td></td>
<td>0.11 Bq/g (3 pCi/g)</td>
<td>Colorado</td>
</tr>
<tr>
<td></td>
<td>1.85 Bq/g (50 pCi/g)</td>
<td>West Virginia</td>
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</table>
## Example State Regulations (Simplified)

<table>
<thead>
<tr>
<th>Waste Form</th>
<th>Radium WAC or Exempt Quantity</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquids</td>
<td>0.185 Bq/l (5 pCi/l) for protected waters&lt;br&gt;2.22 Bq/l (60 pci/l) for other waters</td>
<td>Wyoming</td>
</tr>
<tr>
<td>Water Treatment</td>
<td>7.4 Bq/g (200 pCi/g)</td>
<td>Illinois</td>
</tr>
<tr>
<td>Other</td>
<td>0.15 mSv/y (15 mrem/y)</td>
<td>New Jersey</td>
</tr>
<tr>
<td>Landfill Performance</td>
<td>Ban Oil &amp; Gas Waste</td>
<td>New York</td>
</tr>
<tr>
<td></td>
<td>0.25 mSv (25 mrem)</td>
<td>Pennsylvania</td>
</tr>
</tbody>
</table>
• Use of RESRAD family of codes
• Dose-based site-specific RCRA landfill disposal performance (PA, CO, CA)
• Scenario analysis - reasonable assurance over 1,000 or 10,000 years
• Groundwater, future site resident scenarios
• Landfill intrusion treated as an accident
• Dose limits as performance objectives
Legal Considerations

- Oil & gas exploration and production litigation in the U.S. increasing
- Negligence, private/public nuisance
- Breach of contract (including trespassing)
- Mergers/acquisitions
- Hazardous substance or activity
- Worker/community right to know
Summary

- Commentary on current state-of-the-industry and potential waste issues
- Makes recommendations for developing a full report to address radiation protection recommendations for workers, the public, and the environment
- Commentary has been through numerous council and peer reviews
- In Press!!!
Questions?

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