

Radiation Protection from NORM and TENORM in the Oil and Gas Industry: Regulatory and Non-Regulatory Approaches

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Conference of Radiation Control Program Directors, Inc.

Presented at IRPA-12

October 2008



Background

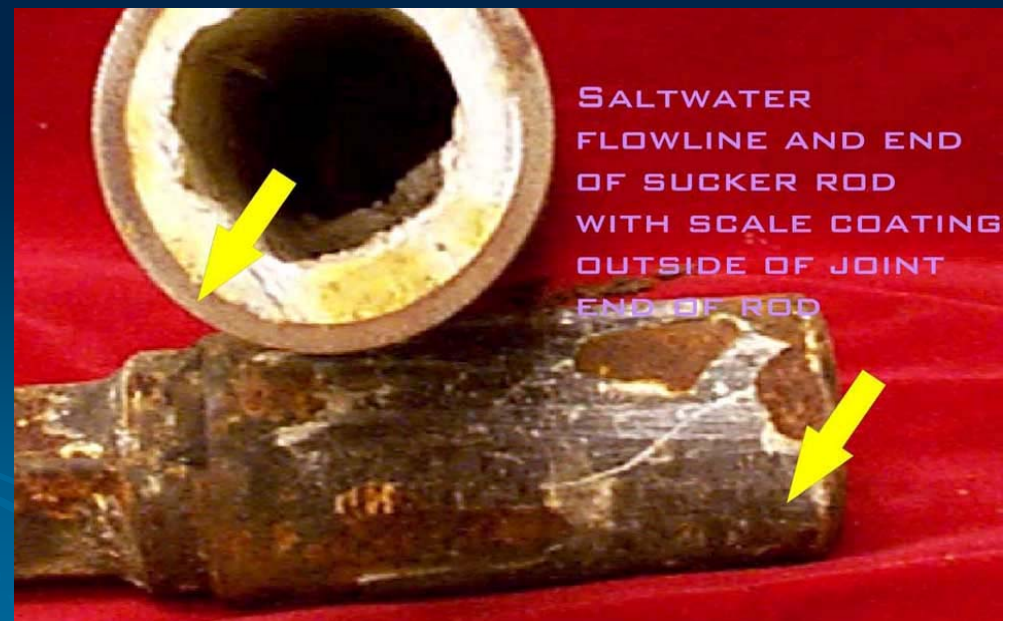
- NORM is ubiquitous in petroleum, produced waters and natural gas.
- The presence of NORM in oil fields was first detected over a century ago.
- Parent radionuclides (^{235}U and ^{232}Th) are not mobilized from the formation.
- Group II elements are dissolved in produced water, including ^{226}Ra and ^{228}Ra .

Radioactive Decay Characteristics of Oil and Gas NORM

Radionuclide	Half Life	Mode of Decay	Main Decay Product(s)
Ra-226	1600 y	Alpha	Rn-222 (noble gas)
Rn-222	3.824 d	Alpha	Short-lived progeny
Pb-210	22.30 y	Beta	Po-210 (α -emitter)
Po-210	138.40 d	Alpha	Po-206 (stable)
Ra-228	5.75 y	Beta	Th-228
Th-228	1.912 y	Alpha	Ra-224
Ra-224	3.66 d	Alpha	Short-lived progeny

TENORM Formation

- Scale formation in pipes and tanks from production water brought to the surface
 - Typically carbonate and sulfate minerals
 - Radium can incorporate as replacement for barium in baryte (BaSO_4)

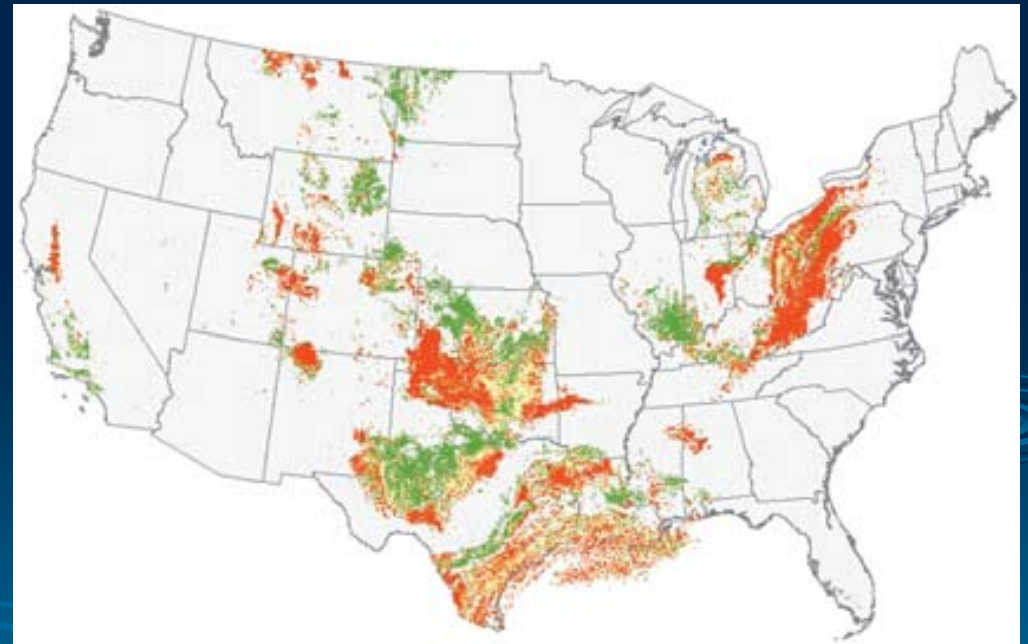


Typical Activity Levels

Radio-nuclide	Produced Water (Bq/L)	Hard Scale (Bq/g)	Soft/Med. Hard Scale (Bq/g)	Sludge (Bq/g)
Ra-226	0.002-1200	0.1-15,000	0.8-400	0.05-800
Po-210		0.02-1.5		0.004-160
Pb-210	0.05-190	0.02-75	0.05-2,000	0.002-0.01
Th-232	0.0003-0.001	0.001-0.002	0.001-0.07	0.002-0.01
Ra-228	0.3-180	0.05-2,800	0.05-300	0.5-50

Geographic Considerations in the United States

- Oil and gas industries have explored ways to define extent of TENORM problem
- Regulatory and non-regulatory efforts more prevalent in geographic regions having the most oil and gas production
- Highest radiation readings from TENORM in Gulf coast area, NE TX, SE IL, and southern KS



Oil and gas producing regions
of United States (lower 48 states)

Geographic Surveys and Considerations

- Other surveys by state radiation control agencies identified TENORM-contaminated oilfield equipment in KY and MI
- No strong correlations between radium activity and location
- Most useful predictive factor for presence of NORM was that Ra activities >3.7 Bq/L were found only in produced waters $>20,000$ mg/L chloride content.

Radiation Protection Issues

➤ Occupational Radiation Exposure

- External
- Internal (enclosed areas)

➤ Training

➤ Guidance in

understandable
language



Exposure of Members of the Public

- Usually very low
- Potential for exposure
 - Contaminated land resulting from decontamination operations
 - Release of equipment for other uses
 - Playground equipment
 - Cattle guards
 - Scrap recycling



Non-Regulatory Initiatives for Oil and Gas TENORM

- IAEA Technical Meetings
- IAEA Safety Guide on radiation protection and radioactive waste management
- United States
 - American Petroleum Institute—awareness and practical protective measures
 - Institute of Scrap Recycling Industries—training and informational material on used oilfield piping and equipment

Regulatory Approaches

- Federal regulations in most countries with NORM
- United States federal radioactive material legislation does not include diffuse NORM and TENORM
 - TENORM not covered under Atomic Energy Act
 - EPA has authority but has not implemented regulations
 - Occupational Health and Safety Administration has developed guidelines for workers based on specific state guidance (Louisiana)

State Regulations

- Most oil and gas states have adopted regulations for TENORM
- Regulations vary somewhat, but all cover:
 - Occupational and public exposure limits
 - Exclusion levels
 - Procedures for handling TENORM
 - Safe disposal options

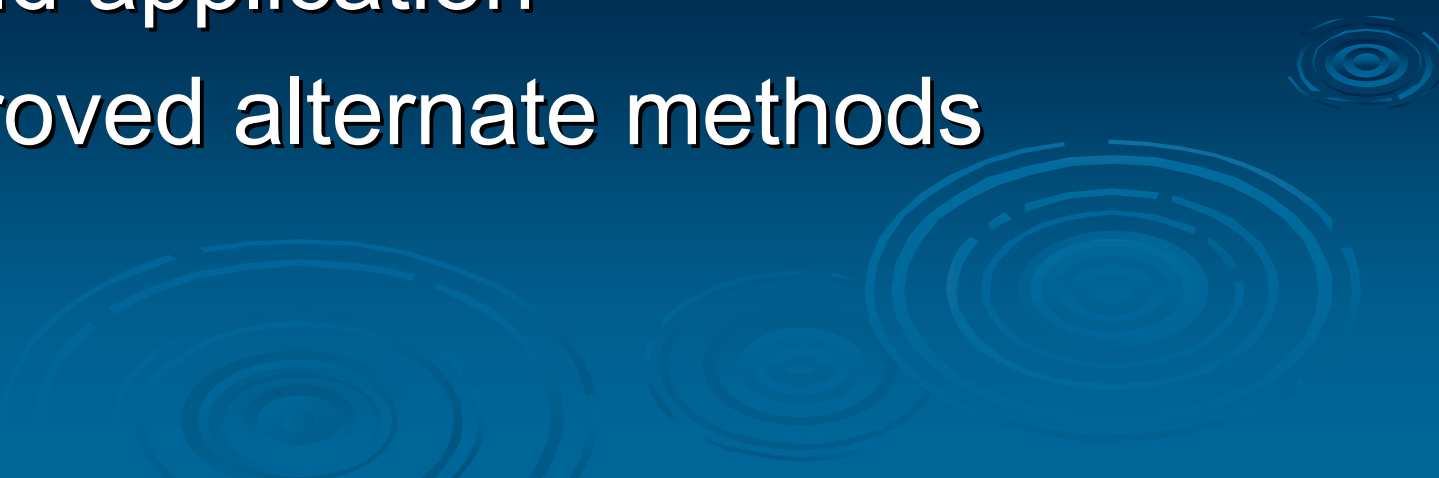
CRCPD's Suggested State Regulations

- Conference of Radiation Control Program Directors
 - National radiation protection organization (also includes international members)
 - Goal of uniformity and consistency of regulations and procedures
- Suggested State Regulations
 - Model state regulations for adoption by state authorities
 - TENORM regulations developed by state and federal representatives (latest version 2004)

Features of SSR's for TENORM

- Exemptions (dose based) -- 1 mSv TEDE
- Basic radiation protection standards
- Licensing provisions
 - General: permit by rule for non-complex activities
 - Specific: complex decontamination service operations and waste management/disposal
- Disposal Options

Disposal Options

- Transfer for storage or disposal at specifically authorized facilities
 - Disposal in permitted solid or hazardous waste disposal facility
 - Disposal by injection wells
 - Limited land application
 - Other approved alternate methods
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Implementation Guidance

- Q & A format
- Describes how to evaluate sites for NORM
- Expansion of licensing descriptions
- Use of computer modeling
- Disposal issues
- Instrumentation
- Other references
- Screening criteria for release of contaminated equipment
- Sample RESRAD summary report



Other Guidance

➤ CRCPD

- Practical guidance to the scrap industry and solid waste facilities for handling radioactive scrap
- Video “Dealing with Stray Radioactive Material” distributed to scrap facilities
- Brochure and poster for scrap and solid waste facilities with pictures of typical scale-contaminated pipe and equipment

➤ National Council on Radiation Protection and Measurements (NCRP)

- Report No. 141—Managing Potentially Radioactive Scrap Metal

Other Guidance (continued)

➤ International Association of Oil and Gas Producers (OGP)

“Guidelines for the Management of Naturally Occurring Radioactive Material (NORM) in the Oil & Gas Industry”

Report No. 412, September 2008

<http://www.ogp.org.uk/pubs/412.pdf>

- Developed by OGP’s LSA/NORM Task Force, lead by Saudi Aramco

Conclusion

- Consistent approaches (regulatory and non-regulatory) for radiation protection from NORM and TENORM in the oil and gas industry should be continued and encouraged for use:
 - Industry worker training
 - Consistent radiation protection standards
 - Easy-to-understand guidance
 - Public information

Information on CRCPD
And
Suggested State Regulations (Part N)
www.crcpd.org

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