

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

Ruth E. McBurney, CHP

Conference of Radiation Control Program Directors, Inc.

Presented at IRPA-12

October 2008



# Background

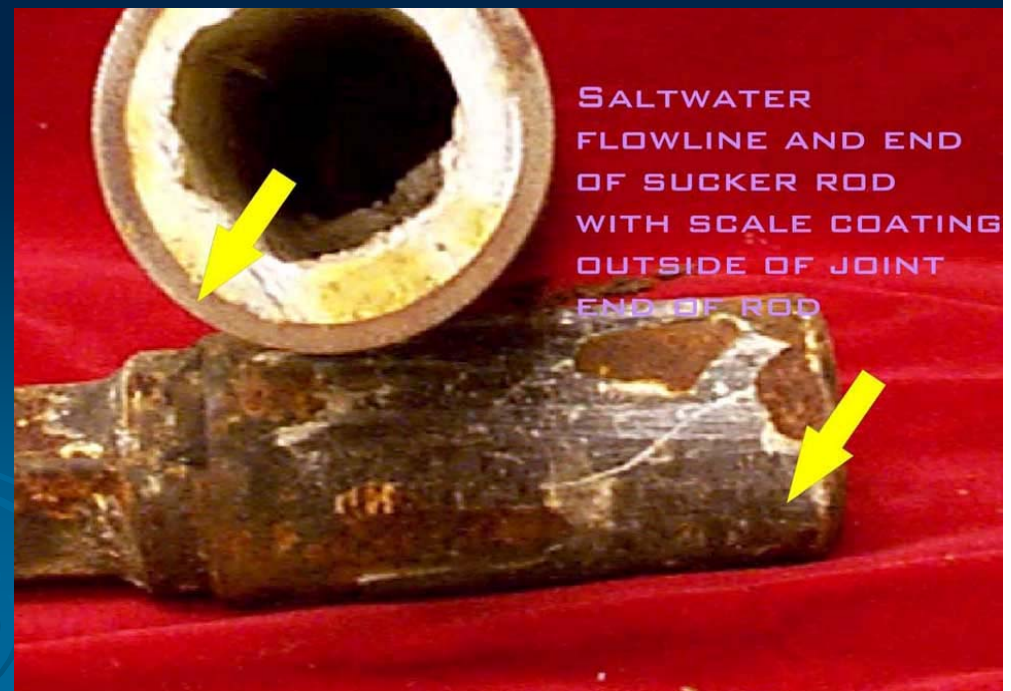
- NORM is ubiquitous in petroleum, produced waters and natural gas.
- The presence of NORM in oil fields was first detected over a century ago.
- Parent radionuclides ( $^{235}\text{U}$  and  $^{232}\text{Th}$ ) are not mobilized from the formation.
- Group II elements are dissolved in produced water,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

# 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 ( $\alpha$ -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 ( $\text{BaSO}_4$ )

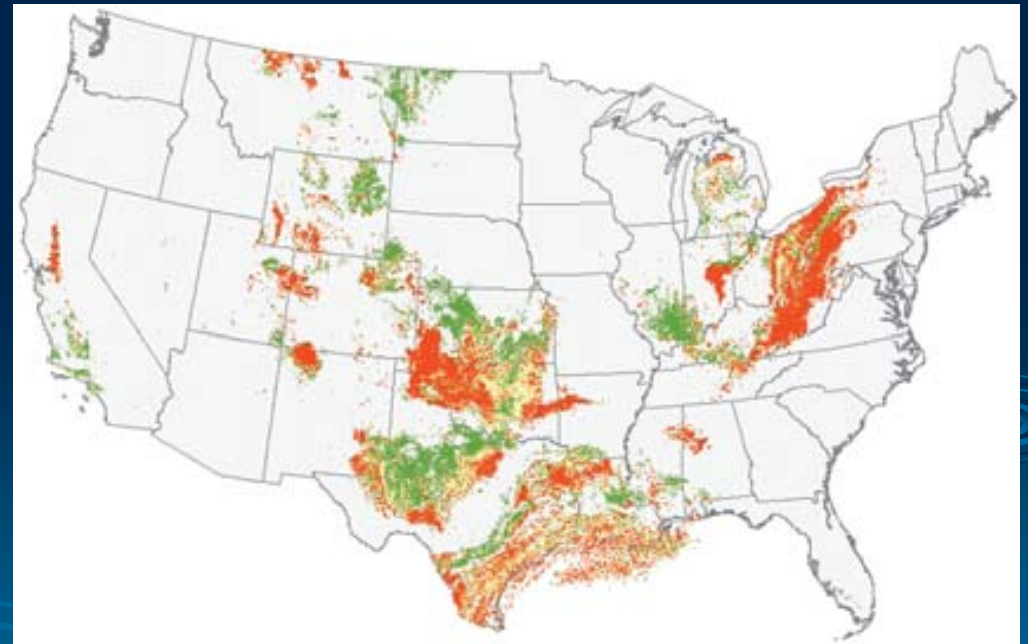


# Typical Activity Levels

| 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

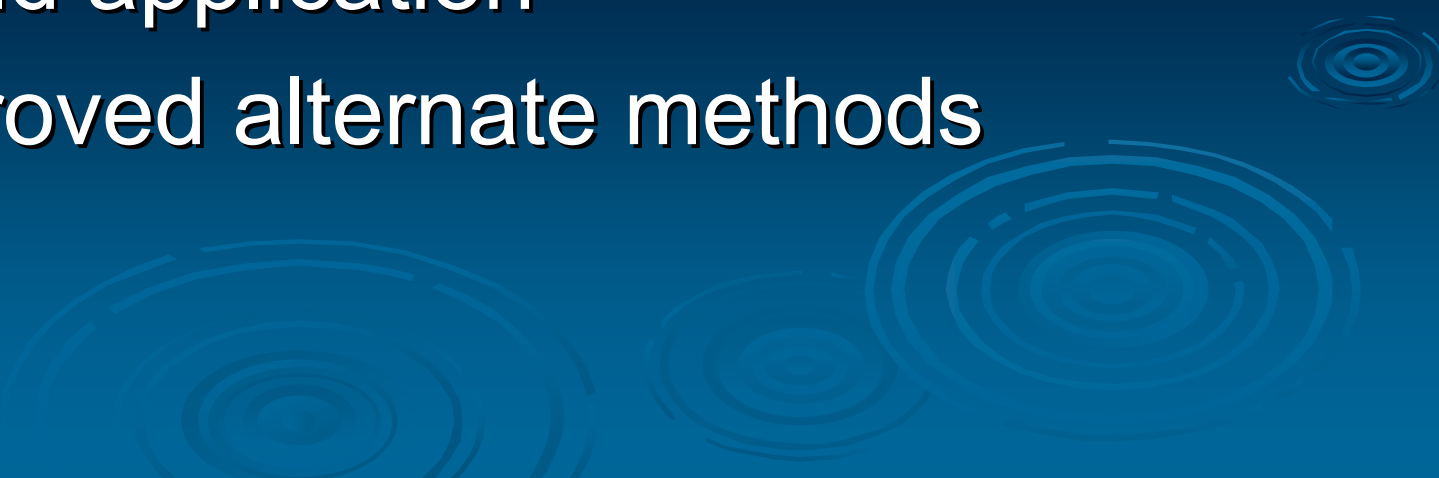
# CRCPD's Suggested State Regulations

- 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
- 

# 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](http://www.crcpd.org)

Ruth E. McBurney  
Executive Director  
[rmcburney@crcpd.org](mailto:rmcburney@crcpd.org)

