UNDERSTANDING RADIATION, NORM AND TENORM

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SECURE energy services
Serving the U.S and Canada
SECURE energy services

- Licensed radioactive materials management – NORM/TENORM
- Surveys, Sampling, and Characterization
- On-site Remediation & Reclamation
- Decontamination
- Demolition & Decommissioning
- On-Site Containment
- Packaging, Transport & Disposal
- Regulatory Consulting/Assistance
- Radiation Training, Safety & Protection Programs
What comes to mind when one thinks about radiation?
NORM – A Lighting Rod for Industry and Landfills
The “R” Word - Radiation

• The fear of the unknown

• Can’t see it, feel it, smell it, or taste it

• Radionuclides are present throughout our environment
  Radium, Uranium, Radon, Lead, Thorium, etc.

• Naturally occurring
Definitions & Terms

- NORM - Naturally Occurring Radioactive Materials
- TENORM - Technologically-Enhanced NORM
  
  Radionuclide concentrations increased by or as a result of past or present human practices

- Why the distinction?
- Picocurie (pCi/g)
Where is Radiation Found?

- Cosmic
- Terrestrial
- Radon/Thoron Gases
- Medical – x-rays, dyes, radiation treatment
- Industrial Sources
  Building materials, processing, filtering, tracers, irradiation equipment
- Other Sources – food, smoking
Natural Background Radiation - a Few Facts

- We live in a radioactive environment
- We are continuously bombarded with radiation energy from space and from the earth’s surface
- We take in radioactive materials with the air we breath, the water we drink, and the food we eat
- Our bodies contain radioactive materials
- Our biosphere is powered by nuclear fusion reactions
- Our earth and weather are respectively shaped by radioactivity and radiation from space – volcanos!
- It has always been that way!
Cosmic Ray and Terrestrial Background Varies Considerably Across US

Variations in Natural Background Radiation in Colorado Across Interstate 70
How is TENORM Generated?
The Public, Regulators, and Employees

• States That Have Seen Very Public TENORM Issues
  • North Dakota
  • West Virginia/Ohio/Pennsylvania/New York
  • Louisiana
  • Colorado – water treatment plant

• Challenges
  • Misinformed & Misconceptions
    • Activists & Community Organizers – purposeful in misinforming
    • Employee Fears
    • Just as Inflammatory as Pipelines, Spills, or Gas Emissions
  • Allowing Disposal or Raising Disposal Limits Is Difficult
  • Not In My Backyard
High Profile Cleanups

Cleanup underway in Noonan

NOONAN — A radiation team cleaning up an illegal oil field waste dump site in Noonan found an underground cache of the material and labels that are possible evidence of companies that contributed to the mess.

The cleanup was expected to take all day Wednesday, with a crew of six workers in oil-streaked suits and respirators pulling tons of low-level radioactive filter socks from an abandoned gas station in this tiny town near the Canadian border.

The dump was discovered in late February and state and local officials started looking for the culprit and making plans to get the material safely disposed.

The property owner is a criminal fugitive in Wyoming and the state is using its own clean up funds instead of forcing the owner to deal with the situation.

Robert Krumberger, manager for Secure Energy Services, said his workers soon uncovered an underground sump area in the old garage, which also was full of the filter socks. He said he called for additional lined containers and estimated the building contained 60 cubic yards of filter sock waste, instead of the 40 originally estimated.
What Are The Issues To Be Considered?

1) Worker Safety
2) Environmental Protection
3) Potential Liability of Generators
4) Public Safety, but mostly **Perception**
5) Regulations & Compliance
Where Do We Find TENORM?

TENORM can be found in the following industrial activities:

• Mining/Ore Processing
• Metal Recycling
• Forest Product Combustion
• Thermal Electric Production
• Fertilizer Production
• Pet Food – Really?
• Ceramics
• Municipal Water Treatment
• Oil & Gas Production
Clarifying Ponds and Tanks
Flowback & Produced Water

Radioactive Tails from Mega Ponds
Mega Ponds in Canada
Filters and Screens
Taming the Wild West (North Dakota)
Filter Socks: Radium-226, -228 and Lead-210
Bottom Hole Pumps
Scale from Produced Water: Radium-226 and-228
Stockpiles of Impacted Tubing
Tanks, Tank Bottoms, Lubricants, and Pipe Scale
Tank Bottoms
Heater Treaters and Fire Tubes
Dealing with the Unexpected
Impacted Containment Floor & Debris
Floor View – NORM and Brine Impact
Systematic Extraction of Impacted Floor
Demolition & Impacted Debris/Soils

Many issues are at saltwater disposals:

North Dakota: 500+
Colorado: 12
Production Water Spill Fills Moat
Form Will Fool You
Levels Vary Dramatically *(most are very low)*

- Geology/Geography
- Processes & Equipment
- Time in Service
Pipeline Inspection Tools: Pb-210
Pb-210 TENORM Contaminated Vessels
NORM Activity Levels

• NORM Unrestricted Release @ 8 pCi/g
  • Treater Waste: ≈ 16,200 pCi/g
  • LPG Waste: ≈ 450,000 pCi/g
Treatment and Recovery Facilities
Workover Rigs & Pipe/Pump Reconditioning
Drinking Water Treatment Plants
Drinking Water Treatment Plants
Potential Concerns: Radium Impacted Waste?

- External exposure
  - Gamma radiation
- Internal exposure
  - Inhalation - Low Level Radioactive Dust (LLRD)
  - Radon gas build up – tanks and pits
- Spread and tracking of Radium Sludge (clothing, pickups, equipment)
- NORM-Impacted Equipment (pumps, pipe, hoses, fire tubes, other)
- Training and Regulatory Requirements
- Transport and Licensed Disposal of NORM Waste
This is a *rare* exception from ND. COGA data does not reflect any elevated readings.
A Glance at the Physics

Two Primary Isotopes of Concern: $^{226}$Ra and $^{228}$Ra

- $^{228}$Ra Half-Life is 5.7 years
- Radon - less than 4 days
- $^{226}$Ra 1620 years

No magic wand or treatment options – the Laws of Physics apply
Decay Chains – The Law of Physics
The Practical Implications

- Where Uranium exists, Radium will always be present
- Where Radium exists, Radon gas will always be present
- Natural radiation will never go away
- There is no escaping radiation in our natural environment
Penetration of Radiation Types

[Diagram showing the penetration of different types of radiation (α, β, γ) through various materials (紙、プラスチック、鋼、鉛) and tissue.]
So How Do We Limit Our Exposure?
Protecting Ourselves

Distance - Inverse Square Law

Source

\[ \text{d} \]

\[ \text{2d} \]

\[ \text{3d} \]
• Radiation at low levels is *not* dangerous

• The *real* threats are *not* where we think they are
  • Not in U.S. nuclear power plants or submarines
  • Not at most U.S. workplaces
  • Not in *most* oil and gas production – e.g. drill cuttings
  • Not in water treatment plants – e.g. backwash residuals
  • Not in U.S. landfills that accept low-level TENORM
Areas of focus are and **should be on higher levels:**

- Medical – including nuclear medicine, x-ray/CT/PET scans
- Industrial irradiation equipment – dog food plants, pipeline inspection, etc.
- Oil and Gas - Filtration of production water, re-manufacturing used pipe/valves, SWDs, pigging waste, radioactive tracers (at first use), and workover rigs
- Water Treatment - filtration units that focus on radionuclide removal, (though most are still at very low levels)
Protecting Ourselves

For most of us, the bigger issues are our Life Choices:

• Where we live
• How much time we spend unprotected in the sun
• If we smoke
• How much we spend time in an airplane, or hiking, or skiing
• Practicing basic hygiene and using PPE at work

What We Don’t Get To Control

• Solar flare-ups
• Volcanos
• Nuclear bombs
• Family history and some illnesses
Life Choices - Cigarette Smoking

- A cigarette smoker gets 1,000 mrem/year effective dose (above background) from Polonium 210
- Smoker’s effective dose = 10x annual public exposure limit (100 mrem (U.S. NRC))
- Chest x-ray = 8 mrem. Smoker = 125 chest x-rays/year !!
- Assuming 15% of population smokes, their total dose/year = 30x more than the total annual dose to all workers at the 100 nuclear power plants in U.S. + all workers at U.S. DOE nuclear installations + all crews on U.S. Navy nuclear ships¹

See Moeller DW and Sun C, Thinking Outside the Box: Polonium 210 in Cigarettes – A Needless Source of Radiation Exposure, Health Physics News,37,4,April 2009
Banana Equivalent Dose

Bananas: A radiation hazard?

Average “K-40 Dose”
= 20 – 30 mrem/yr !

- One banana contains approximately 422 mg of potassium
- The naturally occurring radioactive isotope of potassium, K-40, has a natural occurrence of 0.0117%
- So: about 0.05 mg is radioactive or 13.3 Bq (about 400 pCi) of radioactivity per banana
- If a “bunch” = 10 bananas, that’s 130 Bq (4000 pCi) of K-40 per bunch of bananas
- Your body contains about 4000 Bq of radioactive K-40 (250,000 decays every minute!)
- 5 oz of uranium ore of 0.1% grade, contains as much radioactivity from uranium as K-40 in ten bananas (60 to 80 oz)
Some Radiological Frames of Reference

- Humans are radioactive (*approximate for 150 pound person*)
  - 100,000 to 200,000 pCi $^{40}\text{K}$
  - 30 pCi each U and Ra
  - 100,000 pCi $^{14}\text{C}$
  - 600 pCi $^{210}\text{Pb}$

- Typical annual U intake in foods (pCi)
  - Meat: 50 to 70
  - Fruit: 31 to 50
  - Potatoes: 67 to 74
  - Bakery products: 39 to 44

- Household smoke detector (Americium)
  - Average of 1 million pCi
Exposure From Consumer Products Used Every Day

Sources of Radiation – U.S. Averages

- **NATURAL SOURCES** – 310 millirem/year
  - Cosmic (Space) 5%
  - Terrestrial (Soil) 3%
  - Radon and Thoron 37%
  - Internal 5%

- **MANMADE SOURCES** – 310 millirem/year
  - Medical Procedures 36%
  - Nuclear Medicine 12%
  - Consumer Products 2%
  - Industrial and Occupational 0.1%
Sources of Human Exposure to Ionizing Radiation

- Medical Irradiation: 48%
- Natural Background: 50%
- Releases from the Nuclear Industry: 0.2%
- Occupational Exposure: 0.4%
- Miscellaneous Sources: 0.6%
- Fallout: 0.6%

NCRP Report 160, National Council on Radiation Protection and Measurements
Ionizing Radiation Exposure of the Population of the United States, 2006
Relative Risks

FATAL RISK OF 1/1,000,000 (10^{-6})

40 TABLESPOONS OF PEANUT BUTTER
100 CHARCOAL BROILED STEAKS
2 DAYS IN NEW YORK
1.5 CIGARETTES
10 millirem OF RADIATION
300 MILES IN A CAR
1000 MILES IN A JET
Observations In Colorado

• Very modest levels in most drinking water treatment plants/systems
  • **documenting zero** – verifying safe work environment and the reasonable practices of beneficial use
  • some accumulation in systems that are designed to capture radionuclides

• Occasional, isolated, miscellaneous waste at recycling centers

• Uranium deposits/mining – part of nature and nuclear history

• We have sun and mountains – elevation and mineralization

• Most waste generated by industry in Colorado is not a major health or environmental risk
The Bottom Line - Conclusions

- Some risks are known but already well regulated
- A few waste streams exist that could be better monitored
- A few occupational risks may exist that should be licensed and monitored
- In-state disposal is not a threat to human health or the environment
- Risk-based guidance is not a good solution for industry
- Just because we can measure it doesn’t make it dangerous
- Want to eliminate all exposure to radiation?
  - Stop breathing
  - Bury yourself in a lead-lined coffin
How Should Most People Protect Themselves?

• Limit medical procedures & x-rays as much as possible
• Wear sunscreen
• Don’t smoke
• Test your home for radon
• Workers w/incidental exposure – good hygiene & PPE
Colorado Regs

- Interim Policy and Guidance for Control and Disposition of TENORM issued in February 2007
- Mostly centers on water treatment; guidance is outdated and doesn’t accurately reflect available landfills in the state
- If water treatment residuals > 50 pCi/g Ra or > 15 lbs U at one time - need rad license in CO.
- ≤ 3 pCi/g above background for combined Ra-226 and -228 or Thorium

The limit is simply not justifiable based on human health and environmental risk assessments.
Compacts
What Does Responsible Government Look Like?

1) Science-based education information – the public and industry

2) Establishing *appropriate* regulatory thresholds, if necessary
   - Clear, unambiguous rules and regulations founded in science & health physics
   - Easy-to-implement waste screening & acceptance criteria

3) Licensing of service providers & landfills

4) Ensuring disposal options exist – in- and out-of-state

5) Portal monitors at landfills – not to presume to screen low levels - simply to verify high level materials are not being disposed of improperly
Radiation Detection
Questions?