INTERSTATE Oil & Gas COMPACT COMMISSION

Technologically Enhanced Naturally Occurring Radioactive Materials

TENORM

Reference Guide and Summary of State Regulations for TENORM in Oil and Gas

TENORM Subcommittee of the Environment and Safety Committee

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About IOGCC

The Interstate Oil and Gas Compact Commission (IOGCC) is a multi-state government agency that champions the conservation and efficient recovery and storage of domestic oil and gas resources while protecting human health and safety and the environment. IOGCC provides member states and international affiliates with a clear and unified voice and serves as a primary authority on issues surrounding these vital resources.

Disclaimer

The Environment and Safety TENORM subcommittee of volunteers and member states have provided a wealth of data and other information for this document. The authors and editors have endeavored to summarize this information in an accurate and meaningful way.

The IOGCC strives to provide the most recent information available. Additional information and updated material are always welcomed. Should you have a question about the contents of this report, feel free to contact IOGCC for assistance. Please note, however that a question regarding information from a specific state may be referred to sources within that state, who are the most knowledgeable about their own regulations. Note, too, that readers should consult with the state before relying on any summary, statement, or interpretation of the requirements or procedures of that state.

Preface

Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) contamination in U.S. oil production waste came to the attention of industry and government in 1986. During routine well work in Mississippi, barium sulfate scale in tubing was found to contain elevated levels of radium-226 and thorium-232. Surface disposal of radioactive sludge/scale and produced water (as practiced in the past) may lead to ground and surface water contamination. Those at risk could include oil and gas maintenance workers and nearby residents or office workers.

This reference guide is an update to the 2008 Naturally Occurring Radioactive Materials (NORM) Guidance Document and Summary of State Regulations for NORM in Oil and Gas. In IOGCC's continuing effort to ensure that the latest information is available, volunteers of a subcommittee of the Environment and Safety Committee reviewed the 2008 document and determined that updates were warranted.

One big change is that this updated reference guide uses the term "TENORM" to mean technologically enhanced naturally occurring radioactive materials. "NORM" or naturally occurring radioactive materials is any of the radionuclides or radioactivity present in soils, rocks, and materials since the formation of the earth and undisturbed as a result of human activities. NORM occurs everywhere in the environment. When NORM is disturbed or altered from natural settings or present in a technologically enhanced state due to human activities, the material is known as TENORM. "Technologically enhanced" refers to a relative increase in radionuclide concentrations above background radiation levels as a result of changes to the radiological, physical, and chemical properties of the radioactive material. Oil and gas TENORM are materials that are technologically enhanced due to oil and gas activities.

Radium levels in the soil and rocks vary greatly, as do their concentrations in scales and sludges. The U.S Environmental Protection Agency (EPA) indicates that radiation levels may vary from background soil levels more than 4 becquerels per gram (Bq/g), or several hundred picocuries per gram (pCi/g). The variation depends on several factors, including concentration and identity of the radionuclides; chemistry of the geologic formation; and characteristics of the production process.

A 1988 publication estimates that 30% of conventional domestic oil and gas wells produced some TENORM. In surveys of production wells in 13 states, the percent reporting high concentrations of radionuclides in the wells ranged from 90% in Mississippi to none or only a few in Colorado, South Dakota, and Wyoming. However, 20 to 100% of the facilities in every state reported some TENORM in heater/treaters.

Facilities in the U.S. have been characterizing the nature and extent of TENORM in oil and gas waste, evaluating the potential for exposure to workers and the public, and developing methods for properly managing these low specific-activity wastes. While the majority of TENORM waste streams generated by the oil and gas industry do not pose a risk to workers or the general public, proper handling, processing, and disposal protocols based on screening, monitoring, and analytical data can eliminate or reduce TENORM exposures to workers and the public below acceptable radiation protection levels.

Many state regulatory agencies regulate TENORM waste in oil and gas production facilities. Many of these regulations are based on Part N Subcommittee of the Conference of Radiation Control Program Directors (CRCPD) model state regulations for the control of TENORM (Part N of Suggested State

Regulations for Control of Radiation, 2004). For example, the State of Texas has NORM regulations similar to the Part N regulations. Other states are evaluating the scope of TENORM wastes generated within their boundaries to determine whether new TENORM regulations, or updates to existing regulations, are necessary. This document provides information related to that effort.

Other changes in this reference guide include updates to the discussion of health risks from exposures and environmental impacts; the science behind exemption levels; remediation technologies; final disposition or disposal options; regulatory and regulatory developments or implementation; safety training; data collection and analysis; and jurisdiction and enforcement coordination with other agencies. This document also includes updated information on operations associated with unconventional oil and gas exploration and production, which combine horizontal drilling with enhanced stimulation. These unconventional operations have changed the profile of oil and gas wastes – both in terms of radioactivity and volumes produced.

This reference guide provides thoughtful and feasible solutions based on the best available information from various sources, including radiation protection authorities. For example, the CRCPD's E-42 Task Force published a Review of TENORM in the Oil and Gas Industry in June of 2015, which includes recommendations related to radiological, environmental, regulatory, and health and safety issues to address changes in TENORM issues after 2003, centering on unconventional oil and gas exploration.

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- Conference of Radiation Control Program Directors, Inc. (CRCPD), 2004, Suggested State Regulations for Control of Radiation. Part N Subcommittee – Regulation & Licensing of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM), 2004 Rationale. https://cdn.ymaws.com/www.crcpd.org/resource/resmgr/docs/SSRCRs/N_04-04-print.pdf

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IOGCC has been supporting member states regarding TENORM for over thirty years. IOGCC has collectively worked with subject matter experts from regulatory agencies, professional organizations, and industry representatives to develop this guidance document.

This reference guide provides member states with current reference materials and scientific-based summations about the health physics (radiation safety) during the development, and implementation of TENORM programs.

The following information was developed by the Environment and Safety TENORM subcommittee of volunteers, which included a team of 12 volunteers chaired by Scott J. Winters, a radiation safety specialist that has worked with the IOGCC since 1992. Special thanks to the volunteers of the TENORM subcommittee, listed alphabetically herein:

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Consultant Brief Perspective

Problems Facing the Oil and Gas Industry Regarding TENORM

Health and safety for workers and the general public, and regulatory compliance, are requirements at all workplaces and across all industries. In addition to the more common health, safety and regulatory compliance (HS/RC) issues, the oil and gas industry must sometimes address the presence of TENORM within their products or processes. This brief perspective recognizes and summarizes some of the issues facing the oil and gas industry in seven areas: Regulatory Compliance, Waste Management, Transport and Storage, Measurements, Legacy Sites, Public Perception, and Resources.

Health, Safety and Regulatory Compliance

TENORM regulations as related to the oil and gas industry vary from state to state and generally depend on the processes, type of material, and radioactivity concentrations and/or radiation levels. Certain states may require licensing of oil and gas TENORM and may also have exemption levels below which regulatory oversight is not required. Local ordinances may also include the regulation of TENORM. These varying regulatory environments between and within states can be a challenge to keep up-to-date and to incorporate into the oil and gas industry's HS/RC programs. Some industries operate in environments across multiple state jurisdictions and must consider the appropriate measures required to ensure HS/RC in all situations.

TENORM safety and regulatory requirements will need to be incorporated into HS/RC programs. The concept of "As Low As Reasonably Achievable" (ALARA) is a required component of licensed programs. In addition, all licensed programs require the identification of a Radiation Safety Officer (RSO) or other named responsible individual for implementation of regulatory requirements.

Incorporation of new HS/RC requirements may require the generation of implementing procedures and training of personnel. In general, industry focuses on production and may have limited resources available for incorporation of new HS/RC requirements, especially regarding radiation. This may necessitate cross-trained individuals that perform numerous tasks. Awareness of hazards in the workplace is a requirement, whether the material or process is licensed or not. Therefore, TENORM awareness training, with more in-depth training as dictated by the hazards, must be incorporated into any HS/RC program. HS/RC as related to TENORM can be complex, and incorporates many aspects, some of which are summarized below.

Waste Management

Management of TENORM wastes requires knowledge of the specific HS/RC requirements which depend upon the regulatory jurisdiction, material type, quantities, radioactivity concentration, radiation level, non-radioactive hazardous constituents, and exposure pathways, and disposal options. Waste management programs related to TENORM require knowledge of regulatory requirements, licenses and/or permits, inventories, material characterization (radionuclide concentrations and exposure rates, material matrices,

hazardous components), disposal options and license/permit requirements for site use, transport options, and consideration of costs.

Licenses or permits may require specific documentation or actions prior to selection of a waste management option. Inventories should include all matrices such as soils, sludges, scales, and equipment. Options for material disposition may include decontamination, recycling, injection wells, offsite processing, offsite disposal, or storage. Characterization of materials must consider all regulatory and permit requirements of the generator as well as the receiving site and may involve the costs associated with offsite laboratory analysis. Material may require specific sampling methodologies to assure that it is representative. Offsite disposal, which also includes transport to the disposal site, is often costly and requires consideration of licenses and permits. The specifics of waste management may require the use of subject matter experts and capabilities, such as offsite laboratory analyses, and their associated costs.

Transport and Storage

Transportation of TENORM may be regulated by the U.S. Department of Transportation (DOT) regulations and/or state transportation regulations specific to the packaging and transport methods. States and local jurisdictions may have specific requirements that are more stringent than the U.S. DOT regulations. Determination of transport requirements must be performed by personnel possessing the appropriate training as required by the regulations. Transportation requirements must also consider any requirements associated with the receiving site.

Storage of TENORM must be performed in a secure manner that is protective of health and safety. Measurements to determine compliance with dose limits or quantity limits may be required. Demarcation, posting and security for storage areas may be required.

Measurements

A licensed TENORM program will carry requirements for measurements to ascertain hazards associated with the radioactivity in TENORM. Within the oil and gas industry, the most common hazards are associated with radium-226, radium-228, and their radioactive progeny. **Fig. 1** highlights that both radionuclides are naturally occurring and originate as radioactive progeny within the uranium and thorium series.

It is important to have a good understanding of the processes that generate and concentrate the radioactivity, the radioactive decay series, and the emissions generated so that appropriate measurements can be performed, and the hazards can be assigned. Measurements must also consider the transmission of the radioactive emissions through the media being measured. Alpha emissions, for example, may be wholly or partially absorbed within the media. Beta and gamma scatter interactions will also affect measurements.

The immediate radioactive progeny of radium-226 (Radon-222) and radium-228 (Radon-220) are gaseous. These gaseous radioactive progenies have relatively short half-lives and transform via radioactive decay to radioactive particles (solids), most of which also have short half-lives. The decay processes continue and eventually result in transformations to non-radioactive isotopes. There are some longer-lived radioactive progenies within the uranium series, such as Pb-210 and Po-210, that have longer half-lives which may result in their presence long after operations ceased. This includes gas processing

equipment where gamma radiation is not detectable in the field, but the alpha and beta radiation can be a significant contaminate.

Since the radioactive transformations sometimes involve different elements, there can be concentration or depletion of materials within a certain material process stream. Thus, as stated previously, it is imperative to understand the radionuclides that are present in each branch of the process and perform measurements appropriate to the emissions as well as the applicable conditions.

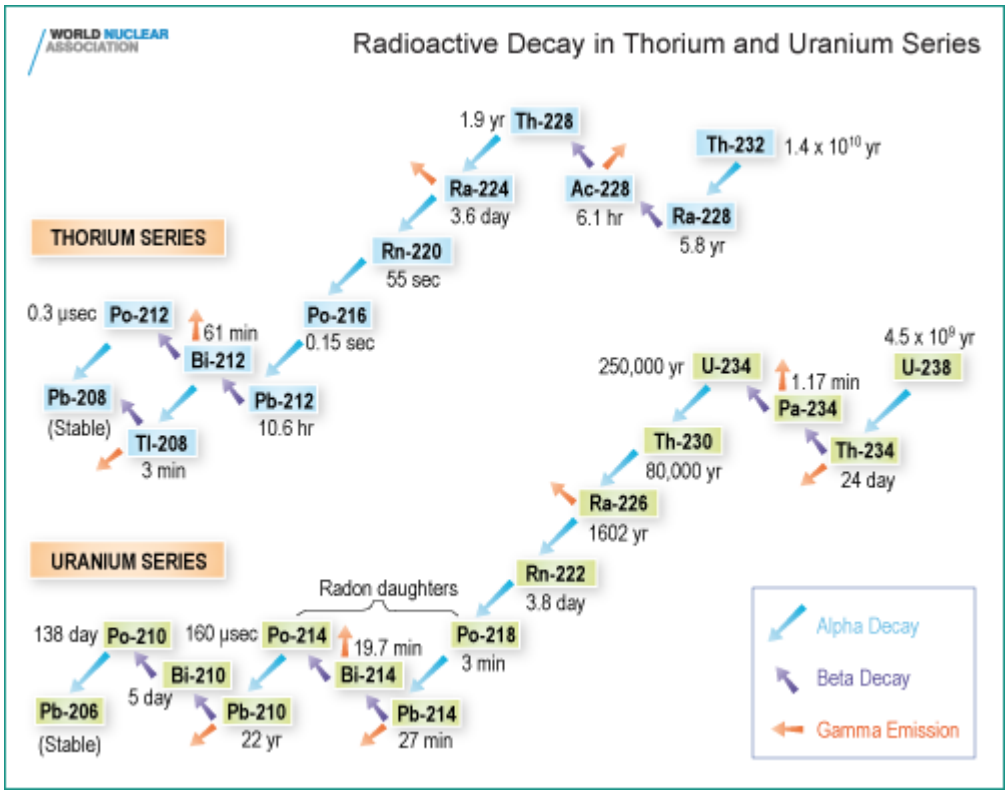

Fig. 1: Displays radioactive decay in thorium and uranium series (World Nuclear Association 2020).

Legacy Sites

Legacy sites from past production, storage, or disposal of TENORM may exist on properties owned, formerly leased, or sold. These sites may be known or unknown. Responsibilities associated with these sites may need to be determined and remedial actions performed as required by regulations. Materials at these sites may include contaminated piping, well heads, vats, tanks, separators, pumps buried materials (e.g., pits), and stored wastes. When required, historical records may need to be reviewed and site assessments performed to determine if remedial actions are required, followed by appropriate disposition of wastes and release of the areas.

Resources

As is common in most industries, the focus must be on efficient production and distribution since this is the means of generating profits. The resources available to ensure HS/RC can be strained when new requirements must be identified, understood, and implemented. As previously discussed, implementation

may require license applications, permits, plans, measurements, procedures, and training. This can result in strains upon HS/RC departments and personnel.

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Conventional vs. Unconventional

Unconventional resources are oil or gas-bearing rocks where the hydrocarbon volume is significant, but matrix porosity and permeability are so low that fluids cannot be extracted economically through a vertical well bore. The reservoir must be developed by drilling horizontal well bores followed by hydraulic fracturing. A horizontal well is one in which the lower part of the wellbore, the lateral, runs parallel through the producing formation rather than perpendicular to it as in conventional vertical drilling. The extended lateral wellbore in the target unconventional reservoir undergoes multistage hydraulic fracturing to stimulate flow. **Fig. 2** compares a conventional well to an unconventional well.

Targeted unconventional reservoirs are typically the organic/hydrocarbon-rich layers in dark-colored shales, fine-grained shaly siltstones, and shaly carbonates. Rheological properties, thermal maturation, organic/hydrocarbon content and distribution, chemo-stratigraphy, and radioactivity have been well-studied from wireline logging and cuttings data.

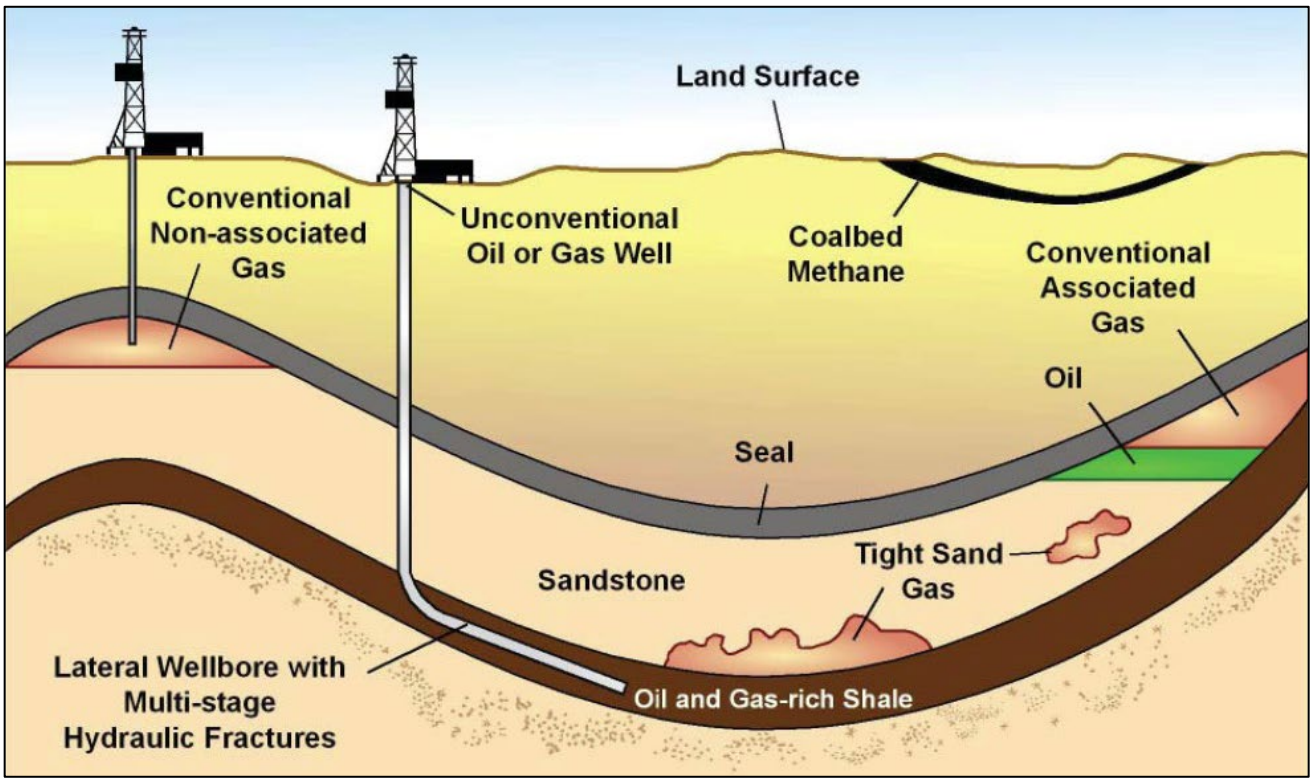

Fig. 2: The geology of conventional and unconventional oil and gas wells (U.S. EIA).

Oilfield NORM/TENORM waste is largely a volume-driven problem. TENORM can be brought to the surface during hydraulic fracturing or shale gas drilling because subsurface geologic formations commonly contain higher amounts of radioactive isotopes than surface rock or soil (Haluszczak et al., 2013), but it is important to note that radionuclide concentrations are typically low in oilfield wastes. Conventional drilling and production operations typically produce smaller volumes of NORM when compared to unconventional drilling and production operations(API, 2000).

Frac fluids used in hydraulic fracturing stimulations are mixtures of water, chemicals and sand pumped at high pressure into perforations in the lateral, in multiple stages during completion. This creates and maintains fractures and enhances permeability pathways to allow flow of hydrocarbons and formation water

from the reservoir into the wellbore. Frac fluids and formation water flow back to the surface during completion, testing, and subsequent production of the horizontal well. These flowback fluids contain high concentrations of brines, dissolved and suspended solids, heavy metals, fracking chemicals, and NORM in varying concentrated solids (Edmiston et al., 2011; Warner et al., 2013).

A NORM exposure hazard is created by accumulation of co-precipitation of radionuclides in calcium and barium scales and sludges in production equipment, pipelines, tank bottoms, and reserve pits (Rich and Crosby, 2013). This form of NORM/TENORM contamination is well-known and studied; however, the much greater volumes inherent in unconventional/horizontal completion and production operations exacerbates the problem (Warner et al., 2013). The amount produced at any one location and any one play varies depending on numerous factors including basin, depth, structure, thermal maturation level, reservoir chemistry, age of production (older wells decline in hydrocarbon production and increasing formation water production), production method (gas lift, submersible pump and other artificial lift significantly increases produced fluid volumes), and degree of play development/maturity of play exploration.

The greatly increased volume of materials accumulated during unconventional exploration and production and the rapid expansion of tight oil and shale gas extraction are what represents the greater level of concern pertaining to NORM/TENORM (Ratner and Tiemann, 2014). The International Atomic Energy Agency (IAEA) states that "for the safe management of NORM residues, the government should establish a policy and strategy that is appropriate to the national situation." This strategy should include an inventory of NORM residues from new and existing NORM activities (IAEA, 2021). In addition, industry, state regulatory agencies, and other stakeholders should review and update their current rules and best practices to deal with the greater volumes and broader geographic distribution of NORM/TENORM resulting from unconventional development. Geltman and LeClair conclude that "Clearer guidance, laws, and regulations may be needed to facilitate safety and health measures in states where inadequacies could potentially harm humans, animals, and the environment."

Exemption Levels for TENORM-Impacted Equipment

In general, states have drawn upon existing standards and guidelines for similar waste-types in establishing release criteria and exemption levels for TENORM. Several states have adopted a level of 5 pCi/g radium in the top 15 cm of soil as the exemption level for unrestricted release of land. A level of 15 pCi/g has also been adopted by most states as a standard for subsurface soil (i.e., soil at a depth greater than 15 cm).

The criterion of 5 pCi/g for surface soil is a health-based standard, established to limit exposure to gamma radiation (and how much radon would seep into a single-family home from residual radioactivity under the home (i.e., 100 m^2.). The subsurface criterion of 15 pCi/g was derived on the basis of cost and feasibility of detecting discrete caches of high activity material. Several states have established dual exemption levels for release of land dependent upon radon flux rates. Typically, the standard is 5 pCi/g of radium if the radon flux is 20 pCi/m2/s or higher and 30 pCi/g if the radon flux is below this level.

This standard was based on the standard for radon established by the National Emission Standards for Hazardous Air Pollutants (contained in 40 CFR 192 and 40 CFR 61), a set of standards promulgated pursuant to the Clean Air Act and its amendments. ALARA is emphasized in the HPS/ANSI N13.53 standard. Characterization of TENORM waste (e.g., scale) generated by the oil and gas industry has indicated that the radon emanation fraction is on the order of a factor of ten lower than the emanation rate

from typical soil or mill tailings and would typically be well below the 20 pCi/m2/s limit. As a result, in states that have established the dual exemption levels, the 30 pCi/g standard would be applied at almost all sites impacted by petroleum industry NORM. It should be noted that the long-lived decay products of radon (i.e., Pb-210 and Po-210) may present an occupational hazard as they build up in high concentrations in equipment internals and filters and during maintenance activities, such as grinding, blasting, or pigging pipelines.

With respect to exemption levels for loose wastes impacted by NORM (e.g., scale, sludge, and soil), states have established levels ranging from 5 to 30 pCi/g of radium above background. In about half of the states, the standard is either 5 pCi/g or 30 pCi/g, depending upon the radon flux rate; in two states, the standard is 30 pCi/g, and in the remaining states, the standard is 5 pCi/g above background. Most states also have a requirement for ALARA so these values are the upper limits for soils. With respect to exemption levels for NORM impacted equipment, most states have established a screening level based on external exposure levels. Typically, this level is 50 uR/h including background; in one state (Mississippi) the standard is 25 uR/h above background. A few states have established an exemption level for contaminated equipment based on surface activity levels. These levels vary from state to state. In addition, fixed and removable contamination limits are established for contaminated surfaces. It is also important to recognize that the U.S. steel industry has a voluntary standard of zero added radioactivity in recycle feed. Even if steel is released from location, there is no guarantee that it will be accepted by the steel recycler. CRCPD's E-46 Task Force to Develop a Workshop and Guidance on Radiation Protection Issues Related to TENORM provides updated information on the suggested regulatory limits.

In some states, an upper gamma exposure rate of 50 uR/h, including background is designated for release of contaminated pipe and equipment. Other states use 25 uR/h above ambient background. It should be noted that the gamma criteria is only good for radium contamination; Pb-210 and Po-210 are not gamma emitters. Surface activity levels for release of contaminated equipment and property have been put in place by some states, usually those found in NRC RG 8.23. Gamma exposure measurements are inexpensive and easy to perform; beta-gamma measurements using a GM pancake detector calibrated for surface activity work well for TENORM (most alpha emitters are also associated with beta/gamma emitters and are easy to detect compared to alpha emitters). Portable field spectrometers can parse K-40 from U and Th series isotopes. Radon is more difficult to sample in the field: pressure must be reduced if sampling the stream, containers properly prepared, and the analytical methods must account for methane rather than air being the carrier. Note that high concentrations of radon and its decay products leaking at high pressure on location may travel beyond the setback limits, especially if the setback limits are only a few hundred feet.

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Instrumentation

There are a variety of radiation survey instruments which are commercially available. However, most radiation survey meters are not intrinsically safe, meaning they are not rated for use in hazardous atmospheres; consequently, use in these conditions will require an authorized permit. **Table 1** identifies different surveying scenarios. Note that there is not one meter or detector that can be used to collect the necessary data.

Table 1. Surveying Scenarios

Purpose	Radiation Type (alpha, beta, gamma)	Check source(s)	Comments
• General area and equipment NORM radiation surveys	• gamma	• Cesium-137	Gamma scintillation detector. Meter reading is in µR/hr.
• Surface contamination	• alpha, beta, gamma	• Cesium-137 • Strontium-90 source for beta • Thorium-230 source for alpha	Thin-window (pancake probe) detector. Meter reading is in counts per minute (CPM). The known efficiency provides estimated disintegrations per minute (DPM) (e.g., Po-210 and Pb-210, respectively).
• Personnel exposure surveys for dose estimation	• gamma	• Cesium-137	Energy compensated Geiger Mueller detector. Instrument is useful if high exposure rates are present because range exceeds that of a micro-R meter.
• Portable gamma spectroscopy	• gamma	• Known standards	Verify channels to be used for NORM subtracting K-40.

The most common NORM surveys can be performed with the first two listed survey meters, for example, an external gamma micro-R meter and a pancake probe to measure alpha and beta emissions from potential surface contamination on interior equipment surfaces. Count rates need to be converted into regulatory units or action levels; these conversion factors are based on the detector's efficiency for a specific isotope. The key to using any survey meter is to ensure that the instrument is properly calibrated, and the operator is suitably trained to use the instrument. Purchase and use of standardized survey meters help to ensure consistency for radiation surveys that are conducted and simplifies user training for operators.

The frequency of surveys depends on the maximum radiation levels found. Where readings do not differ from background, repeat measurements are not necessary for several years unless changes in operational

characteristics of the field occur such as water flood operations or work requiring opening equipment is planned. Fields with known NORM scaling tendencies should have more frequent NORM surveys to assess the impact of potential accumulations. Examples for monitoring production equipment, oil production areas and processing facilities, both externally and internally, including radon concentrations, could include:

- Annual surveys of the asset while in operation (this should allow sufficient time for NORM scale and sediment, if present, to accumulate to detectable levels).
- Prior to maintenance, tank cleaning, turnarounds, shutdowns, or other activities requiring the opening of equipment with potential NORM.
- Prior to asset retirement and/or decommissioning activities.
- Prior to transfer or sale of the asset or scraping of processing equipment.
- Periodically based on operational concerns such as scale formation, and/or regulatory requirements.

Field Data Collection

The following information is provided by the State of Michigan's Department of Environment, Great Lakes and Energy (EGLE) for the purpose of sharing one of several methods for collecting field data. The collection and processing of said information can assist with the recording of radiological data collected in the field by agency inspectors.

The objective is to obtain a statistically significant dataset of TENORM at wells and facilities using discrete data for equipment at facilities that can be used to generate maps to highlight affected areas and/or formations. The critical component of collecting field data is to ensure consistency of the data by controlling entry options for accurate processing and reproducing the collected data as shown in **Fig. 3**.

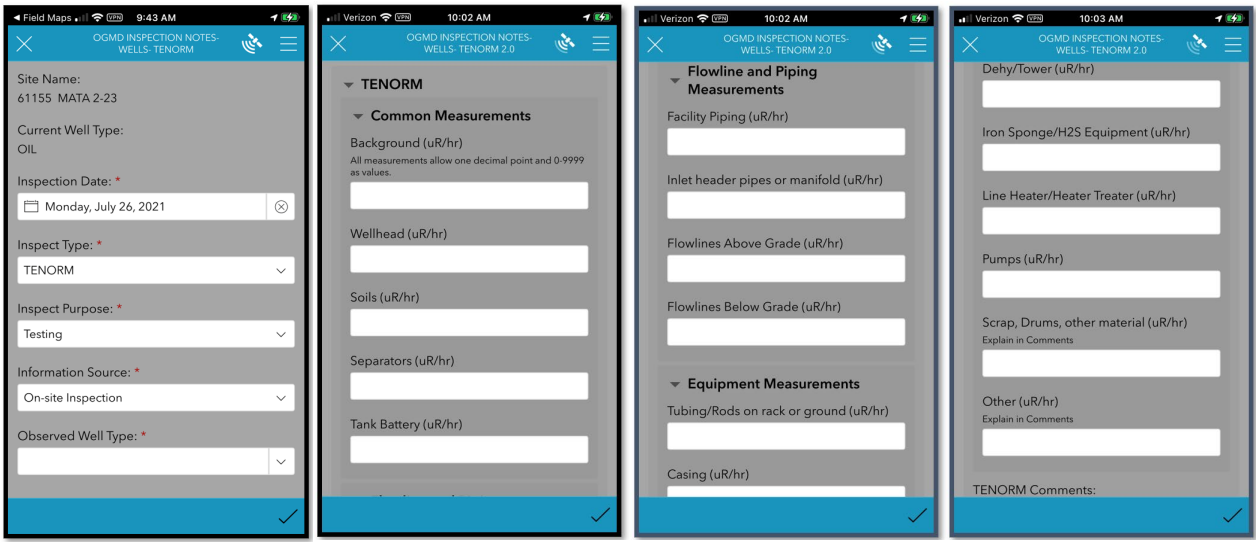

Fig. 3 Michigan team using Risk Based Data Management Solutions (RBDMS) for collecting TENORM field data (Michigan EGLE).

TENORM was measured and recorded for discreet onsite locations including wellheads, soil, flowlines, tank battery, separators, etc. **Fig. 4** shows the different locations 2,126 TENORM measurements collected in 2021 by Michigan EGLE.

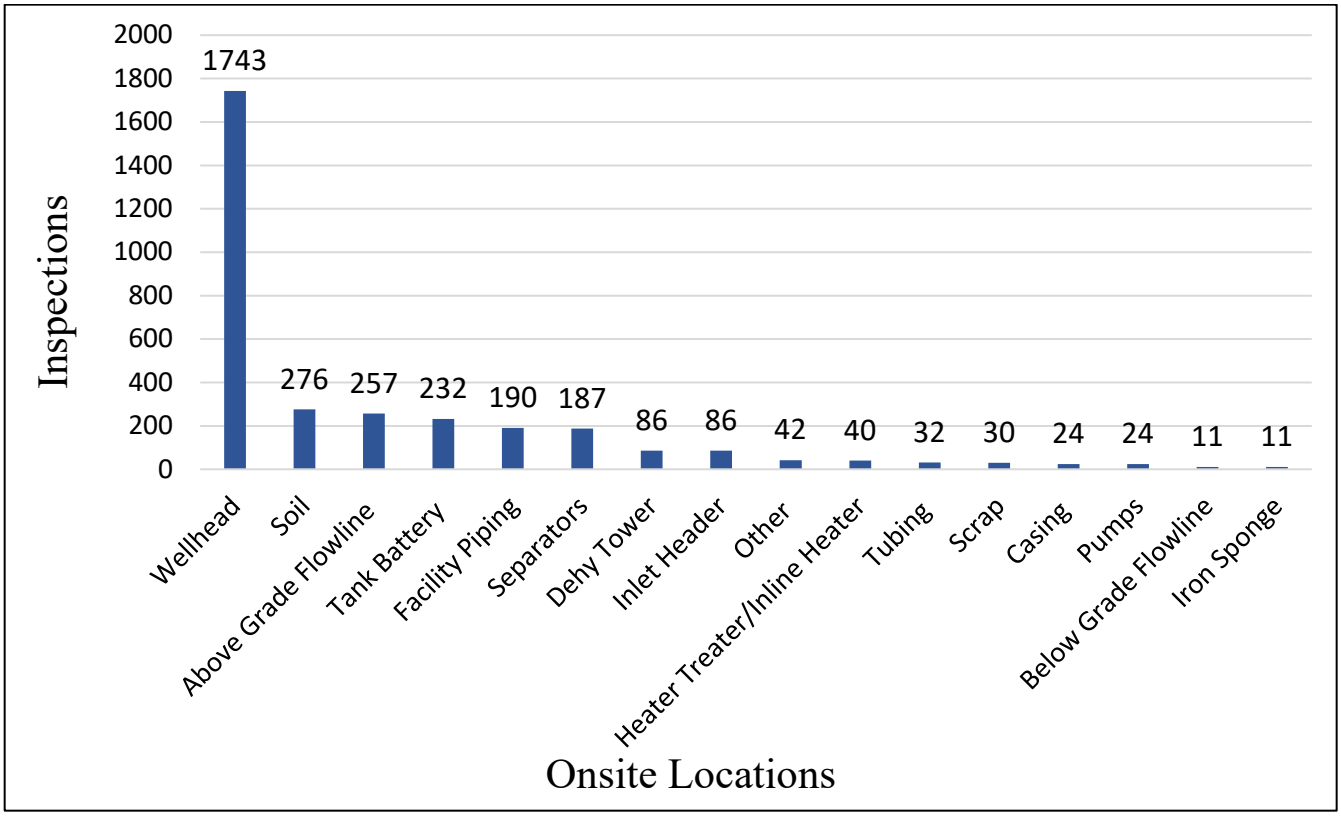

Fig. 4: Michigan's TENORM measurement locations conducted in 2021 (Michigan EGLE).

One advantage associated with the data collection is that background levels were measured and recorded for each inspection location. Background measurements collected in 2021 are shown in **Fig. 5**. The results allow statewide characterization of the natural background levels for specific geographical or geological regions. Another advantage shown in **Fig. 6** is that the data collected can be used to compare the impact TENORM has on certain equipment and land.

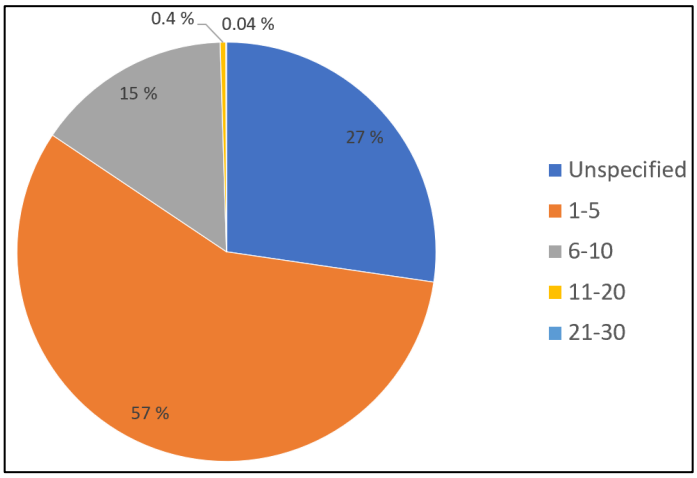

Fig. 5: Background levels collected in 2021 near each inspection location. Units are in uR/hr (Michigan EGLE).

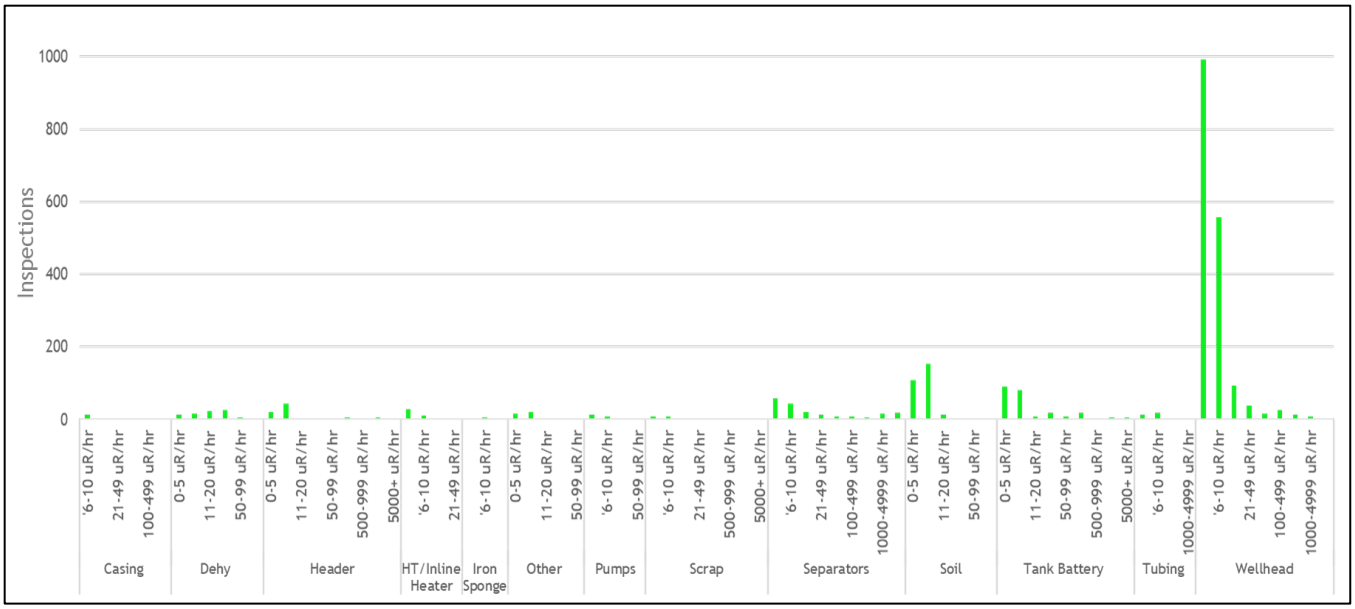

Fig. 6: Comparing number of inspections with TENORM levels collected at wellheads, equipment, and land in 2021 (Michigan EGLE).

Subsequently, an agency can make a comparative assessment of the overall impact regarding background NORM levels versus elevated TENORM levels at facilities surveyed. 91 percent of all measurements collected are under 20 µR/hr, see **Fig. 7**.

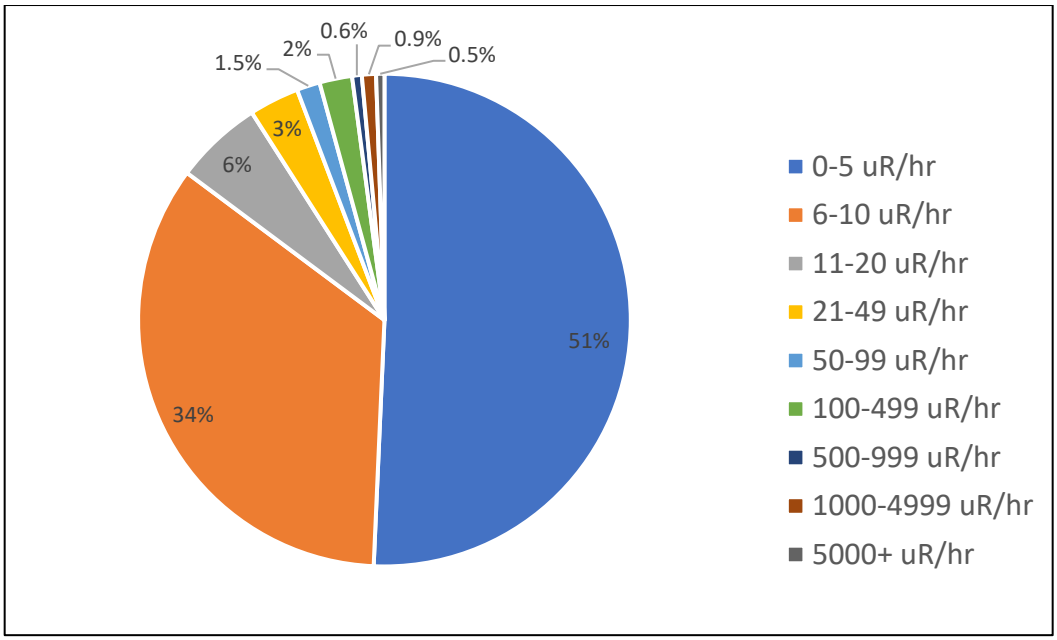

Fig. 7: TENORM levels measured at wellheads and at various equipment collected in 2019, 2020 and 2021; background measurements not included (Michigan EGLE).

References

- State of Michigan, Department of Environment, Great Lakes, and Energy (EGLE), TENORM Field Note App PPT.

Decontamination

Decontamination is a general approach to safely removing NORM/TENORM from equipment and piping. These are typically conducted by a third-party contractor specializing in this type of work. These contractors must be specifically licensed by the appropriate state agency, and may require local permitting, for the services they provide, or securing reciprocity when performing services in another state. Similar work performed in regions without locally applicable regulation or authorities should follow equivalent work practices to adequately manage generated NORM. Decontamination encompasses, but is not limited to, mechanical cleaning methods such as high-pressure water blasting, chemical treatment, drilling/reaming, or vacuuming systems, as described in the **Table 2**.

Table 2. Decontamination Methods

Decontamination Method	Description
• High Pressure Water Blasting	• Water blasting is one of the most common methods to clean scale from NORM-impacted equipment, pipes, and tubing. High pressure water blasting is defined as water jetting using pressure above 750 psi. For NORM scale cleaning operations, pressure ranges typically from 10,000 psi to 30,000 psi. This process can generate NORM impacted aerosols that may need to be controlled to reduce potential exposures and prevent release of material to the surrounding environment. It may also generate considerable quantities of contaminated water requiring treatment.
• Drilling/Reaming	• Drilling or reaming is generally used to clean production tubing and pipes. The tubing will be placed on a cleaning rack and a reamer inserted to remove inner NORM-impacted scale materials. This process can generate NORM-impacted dust and scale when implemented as a dry operation. Wet drilling processes can help to reduce amounts of dust propagation in the air.
• Vacuuming	• Wet or dry vacuuming systems are an effective way to remove loose material before manual handling or cleaning of NORM equipment. These specialized vacuum systems should be properly filtered to prevent release of material to the air and surrounding environment.

• Chemical Decontamination	• Numerous chemical products can be used to remove NORM/TENORM from surfaces, including hard to reach areas. The material is usually submersed in a bath containing chemicals that remove or greatly lower the contamination. Liquid and solid residuals must be managed properly, and these activities are conducted by licensed contractors

During these operations, areas of cleaning may create airborne TENORM which may require containment with filtered ventilation systems. In addition, process liquids or wash out water should be contained, filtered, and, if possible, recycled again for use in TENORM decontamination. Wash water should be disposed of only through methods that are in accordance with local regulations. A separate handling area may also be necessary to inspect and survey incoming equipment being sent for decontamination, to carry out radiation surveys, and to segregate decontaminated items from equipment requiring cleaning.

Containment, Transportation, and Storage

Containment

Whenever NORM needs to be stored, it should be kept in a suitable container which should comply with the following characteristics:

- Be in good condition with no visible signs of internal or external corrosion and is made of a durable material to provide adequate containment of NORM wastes for the duration of storage.
- Be made of or lined with materials that will not react with or be incompatible with the NORM waste so that the ability of the container is not impaired or compromised (e.g., hydrocarbon compatible for oil impacted material).
- Be ultraviolet (UV) radiation resistant to prevent sun damage (e.g., container cracks).
- Be closed and sealed during storage and re-openable and re-sealable when necessary.
- Bear the radiation symbol and provide a label clearly indicating NORM-impacted waste is present as well as other materials (e.g., soils, sludge, chemicals, etc.). It is also recommended that the origin of the material (e.g., well, platform, etc.), surface radiation measurement, and estimated total activity be documented in the project records.
- Be resistant to normal storage temperatures.
- Be stored in a dry area and prevented from water accumulation to reduce corrosion potential.
- Be physically robust to prevent damage during transport (note, specific requirements apply to regulated NORM during transport/shipment).

Transportation

NORM stored in containers or within sealed equipment should be protected in such a manner as to ensure no leak/spillage of NORM occurs during transport. Individuals performing any task associated with the preparation and shipment of said packages should be specifically trained on radioactive shipments in accordance with the U.S. DOT rules 10 CFR 172, Subpart H. **Table 3** lists U.S. DOT specification packaging for Class 7 NORM material types.

- Before shipping any NORM-impacted equipment or waste, the receiving location or company (e.g., waste management services contractor) should be notified.
- The operator of the transport vehicle should be provided with an emergency plan detailing the actions to be taken in the event of a reasonably foreseeable accident. The NORM transporter should be aware and capable of implementing the contingency arrangements to be taken in the event of an accident.
- The transport vehicle carrying Class 7 NORM-impacted equipment and wastes should bear appropriate radiation signage and placards as required by U.S. DOT, or other governing agencies where appropriate (e.g., for public roads).
- Records should be kept, and these may include the following:
    - NORM material description (e.g., impacted equipment, scale, sludge, scrapings, etc.).
    - Volume/quantity of NORM material transported and the internal and/or external survey readings and estimated maximum activity level if available.
    - Method of transportation.

- Origin or facility where the NORM waste was generated.
- Final destination.

Table 3. Typical U.S. DOT Specific Packaging Requirements for Class 7 Shipments

U.S. DOT Specification Packaging for Class 7 NORM Material Type	Typical Packaging
• Bulk Class 7 material is normally transported in Industrial Package Type -1, 2, or 3, (IP-1),(IP-2),(IP-3). These packages have specifications in the regulations, but they do not require either DOT approval. Rather, these packages are "self-certified" by the manufacturer or user that they meet the design requirements specified in the regulations.	• Most 55-Gal drums will meet IP -1 specifications, those meeting IP-2 specifications are generally marked with a UN code of IH2. Waste skips, half heights will also normally meet IP-1 specifications. • Records documenting passing test results for IP-2 and IP-3 must be maintained by the Mfg. or user of such containers. IP-1 packages are exempt from this documentation requirement.
• NORM-impacted equipment (e.g., tubulars, heater treaters, vessels, etc.).	• Typically, the equipment with the openings sealed is shipped as Surface Contaminated Objects (SCO) as an IP-1 or IP-2 package depending on their radiation level. Normally the sealed equipment is considered an IP-1/ IP-2 package. • In some cases, this equipment may be shipped as Limited Quantity material. In these cases, the sealed equipment itself is considered a "Strong Tight Package"
• Samples of NORM.	• Samples of NORM are typically shipped as Limited Quantity shipments as such the requirement is for "Strong Tight Container". In other words, "a container or package that ensures there will be no leakage of radioactive material under conditions normally incident to transportation." • For NORM samples, a typical example may be a plastic sample jug, inside a plastic bag, in a cardboard box.

Storage

It is important to properly contain NORM impacted materials in preparation for storage and disposal. Careful management of NORM storage areas and containers is vital to preventing unintended exposures and/or environmental contamination. Storage time limits may vary according to local regulations that may require local, state, or federal approval and licensing for said activities. Provided below are common industry practices for control and storage of NORM from oil and gas operations.
The preferred secure storage of NORM is outdoors on a covered paved area. If NORM is stored indoors, ventilation should be sufficient to ensure that radon emitted from the stored NORM does not exceed the EPA recommended action limit of 4 pCi/L (0.15 Bq/L) (U.S. EPA, 2022).

- The storage location should prevent contamination of the underlying ground, groundwater, or nearby surface waters.
- Storage areas should have signage indicating the radioactive hazard and be secured by fencing from unauthorized access, handling, and removal from the storage site. Secure storage sites may include a designated offshore platform, inland shore bases, well locations, or inland central storage sites.
- Tubulars and vessels containing NORM should be segregated from other tubulars and vessels and stored in a posted location with end and openings capped. Caps should be without holes, or with the ends sealed.
- Commercial storage facilities may be required to monitor and control gas discharged from venting mechanisms.
- Regular inspections should be conducted to ensure the integrity of the storage area and containers therein for signs of leakage, deterioration, and proper labelling. Records of these inspections should be documented and properly maintained.

References

- American Petroleum Institute (API), 2020. "NORM" in the Natural Gas and Oil Industry. https://www.api.org/-/media/Files/Oil-and-Natural-Gas/Hydraulic-Fracturing/Environmental-Stewardship/NORM-In-the-Oil-and-Natural-Gas-Industry.pdf
- Massey, Charles, The Nuclear Safety and Nuclear Security Interface on NORM Transport: Experience, Challenges, and Opportunities. International Atomic Energy Agency. https://nucleus.iaea.org/sites/orpnet/home/Shared%20Documents/T2-Massey-Interface-NORM-transport-IAEA.pdf
- U.S. Department of Transportation Code of Federal Regulations, 2021, Title 49 Part 172 Subchapter H. Code of Federal Regulations. https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I/subchapter-C/part-172
- U.S. Environmental Protection Agency (EPA), February 2022. Radiation Protection, TENORM: Oil and Gas Production Wastes. https://www.epa.gov/radiation/tenorm-oil-and-gas-production-wastes
- U.S. Environmental Protection Agency (EPA), July 2022. Radon. https://www.epa.gov/radon/what-epas-action-level-radon-and-what-does-it-mean

Final Disposition and Disposal Options

There are numerous proven options for final disposition, but generally permitted industrial landfills and downhole injection appear to be the most common in the U.S. The regulatory environment, availability of facility options/acceptance criteria, economics, and long-term liability of NORM waste are the key factors influencing disposal decisions from an operator's standpoint.

For impacted pipe and equipment, there is a direct landfill option for pieces of equipment, but landfills generally prefer to have little void space for deposited waste. As an alternative there is the common option to clean equipment (usually with hydro-blasting techniques) and recycling scrap metal, however, the issue there lies with wastewater management post-cleaning. This should be thought out considering factors of cost and whether human health and environmental protective measures are in place with various decontamination protocols. **Table 4** below summarizes some of the more common NORM disposal options. Refer to the state summaries section for specific authorized activities.

Table 4. Common NORM Disposal Options

NORM Disposal Options	Description
• Burial	• Burial of NORM usually involves placing NORM at a regulatory prescribed depth to protect the general public and environmental impact. Consideration of local approvals and the need for deed restrictions or limits on future land use must be taken into consideration prior to using this option.
• Injection	• Sludge and scale wastes can be disposed of by injection into a well that will be plugged and abandoned or fractured into formations that are isolated geologically to ensure groundwater contamination potential is minimized. Currently there are no known limitations on radionuclide concentrations of NORM that may be disposed through injection presuming injection permits allow. • Solid NORM materials intended to be disposed of through injection should be pulverized and processed before entraining with liquid wastes to form injectable slurry. • Well abandonment operations are also an opportunity to dispose of NORM, if approved by local regulatory authorities. Various states in the U.S. provide regulations on the disposal of NORM in plugged and abandoned wells. Generally, NORM can be encapsulated in steel tubulars that are placed into a wellbore and diffuse NORM can be mixed with slurry for injection.

• NORM-permitted landfill	• Disposal of NORM-impacted material at certain NORM permitted landfills may be a possible option if allowed by local regulations. Landfill cells for disposed NORM or other radioactive material may require special permitting and environmental monitoring and controls. • Another viable option for disposing low level radioactivity concentration NORM in certain non-hazardous or sanitary waste landfills which would typically accept lower concentrations of NORM.
• Overboard discharge (for offshore operations)	• Overboard discharge of low-level radioactivity concentration NORM such as drill cuttings and produced water has become extremely limited as most permitting, such as NPDES, prohibits the discharge of sediments and other materials.

Personal Protective Equipment

TENORM, like other types of radioactive materials, has the potential to expose individuals to external and internal radiation hazards. The extent of such a potential hazard is dictated by the type and amount of radiation, associated components (e.g., dust, dirt, sludge, scale), distances relative to the body (e.g., external vs. internal), total time of exposure, and any attenuation (shielding) factors.

Personal protective equipment (PPE), such as gloves, boots, goggles, suits, and respirators are all possible items one can use to protect against internal exposure and cross-contamination. A survey meter is a key extension to the list of PPE as it can help identify the potential for external and/or internal exposures from ionizing radiation.

External exposure to radiation is attributed primarily by the emission gamma radiation as it can penetrate through dense materials, such as process equipment. Like alpha and beta radiation, it is an internal hazard if inhaled, absorbed, or ingested. The use of the appropriate PPE should be determined by a health physicist (radiation safety professional) when assessing the radiological conditions and potential exposure pathways for any survey or work around or with TENORM.

Fixed, removable, and airborne contamination measurements are necessary to determine the need for respiratory protection for workers. There are different regulatory limits between fixed and removable radioactivity regarding surface contamination. However, industrial settings present a worse-case scenario where all surface contamination (fixed and removable) is considered removable and a potential to become airborne. It is common health physics practices to establish an action level, based on detector efficiency, that accounts for all detectable radioactivity and the likelihood of attenuation from other media and moisture that may be present.

Most exploration and production workers in coveralls, boots, gloves, and eye protection are afforded good protection from TENORM contamination on skin. There may be times when Tyvek coveralls and booties are recommended, such as when cleaning out tank bottoms. In rare situations, like pipe rattling and tank cleanouts, respiratory protection should be provided (not cloth masks, respirators). Workers in confined areas like tanks may also be exposed to elevated levels of radon and its decay products.

Hazard analysis and risk management are an integral part of health and safety, including exposures from TENORM. Radioactivity is rarely the primary hazard in exploration and production (and decommissioning) and a graded approach is recommended by the International Commission on Radiological Protection (ICRP) in Report #142. Additionally, the Anticipate, Recognize, Evaluate, Control, and Confirm (ARECC) approach of hazard analysis and risk assessment used by industrial hygiene is a good method for evaluating such hazards and risks, and the appropriate protections.

References

- Clement, C.H., Fujita, H., Lecomte, J-F., et al., 2019, Radiological Protection from Naturally Occurring Radioactive Material (NORM) in Industrial Processes. *Annals of the ICRP, Publication 142, Vol 48, No. 4*. https://journals.sagepub.com/doi/pdf/10.1177/ANIB_48_4.
- Heidel, Donna, Flinta, Dan, MacFarlane, Matthew, et. al., 2020, Understanding How ARECC Works Within Occupational Exposure Assessment. American Industrial Hygiene Association (AIHA). https://www.aiha.org/education/frameworks/competency-framework-understanding-how-arecc-works-within-occupational-exposure-assessment.

Training Overview

Program administrators should evaluate the responsibilities of supervisors and field personnel to determine what activities might benefit from formal radiation safety training. Administrative level of training may benefit those responsible for developing policies for agency enforcement. Managerial level of training might benefit supervisors that oversee field operations, and a combination of classroom and hands-on training could support field inspectors that are responsible for enforcement and data collection.

The extent of training based on the following topics can be tailored to meet any level of training requirements. A qualified instructor can adapt these and other topics to a length of time and detail necessary to ensure participants fully understand the materials presented and assigned duties. Field training and comprehensive examination of both book and field knowledge is critical to support employee safety.

1) **Basic Health Physics**
   a) Atomic Structures
   b) Types and Characteristics
   c) Units of Measure
   d) Rules and Equations
2) **Biological Effects**
   a) Potential Sources
   b) Factors and Variables
   c) Targets and Interactions
   d) Potential Impact
   e) Relative Risk
3) **Radiation Protection**
   a) ALARA Concept
   b) Methodologies
   c) Regulatory Aspects
   d) Industry Standards
4) **Industrial Radiation Safety**
   a) NORM, TENORM, Man-made
   b) Industries and Uses
   c) Past Incidents/Relative Hazards
5) **Radiological Instrumentation**
   a) Theory and Applications
      i) Portable, Fixed and Area Meters
      ii) Dosimetry, Laboratory/Analytical
   b) Inspection and Maintenance
      i) Calibration and Efficiencies
6) **Data Collection and Documentation**
   a) Screening/Monitoring
   b) Dose Rate Surveys
   c) Performing Contamination Surveys
   d) Collecting Samples for Analysis
   e) Fixed Area/Effluent Monitors
   f) Laboratory/Analytical Equipment
7) **Regulatory Overview**
   a) Agencies and Jurisdiction
   b) Guidelines and Regulations
   c) Inspections
   d) Correspondences
   e) Enforcement
   f) Investigations
8) **Radiation Safety Management (RSM)**
   a) Operational and Emergency Procedures
   b) Permit/License Application/Condition
   c) Documents/Reporting
   d) Training Criteria
   e) Trade Interactions
9) **Resources**
   a) Agency Guidelines and Regulations
   b) Professional Research Documents

References

- Health Physics Society, 2016. Radiation Safety Officer (RSO) Qualifications. https://hps.org/publicinformation/ate/faqs/rso.html
- Health Physics Society. "Ionizing Radiation Safety Training for Workers." ANSI/HPS N13.36, 1st Edition, 2011.
- U.S. Department of Labor, Occupational Safety and Health Administration (OSHA). Ionizing Radiation, Control & Prevention. Ionizing Radiation - Control and Prevention | Occupational Safety and Health Administration (osha.gov)

Identify State Inspector Task for Training

In New York, during well site inspections, oil and gas inspectors from the Division of Mineral Resources are required to refer certain leak and/or discharge incidents to different divisions within the same agency, or in some cases, to a different agency within the state. For clarity, the Division of Mineral Resources is a "division" within the Department of Environment Conservation, which is an "agency" in the state.

See below for examples that are specific to New York:

Example 1: During a routine inspection at a well site, an oil and gas inspector discovers crude oil on the ground. The inspector must refer the incident to a different division within the same agency.

In this case, the oil and gas inspector from the Division of Mineral Resources would refer the incident to the Division of Environmental Remediation, because oil spills are under their jurisdiction.

Example 2: During a routine inspection at a well site, an oil and gas inspector discovers an active and significant brine and/or production fluid discharge. The inspector must refer the incident to a different division within the same agency.

In this case, the oil and gas inspector from the Division of Mineral Resources would refer the incident to the Division of Water, because discharges of this type and magnitude, which may threaten water bodies or cause substantial soil impacts that could lead to impaired water quality, are under their jurisdiction.

Example 3: During a routine inspection at a well site, an oil and gas inspector discovers a gas leak from a valve stem located on the pipeline side of the meter. The inspector must refer the incident to a different agency within the state.

In this case, the oil and gas inspector from the Division of Mineral Resources (within the Department of Environmental Conservation) would refer the incident to the Department of Public Service, because the location of the leak (e.g., from the gas pipeline and not the wellhead) is under their jurisdiction.

Regulatory/Legislative Development and Implementation

Colorado

Colorado is the most recent state to update their TENORM regulations, including oil and gas. They are comprehensive and include registration and specific licensing where needed. The focus is on radium, radon, and its decay products. Uranium and thorium residuals from exploration and production in Colorado are to be dealt with under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), despite the stricter limits and increased liabilities that it puts on generators. Sludges, filter wastes, etc. from oil and gas, will still have a radium component, so they must be characterized before disposition. The Colorado rules also address pigging wastes, surveys of the pipe, and other criteria. The rules went into effect in early 2022 and are enforceable as of July 2022.

Ohio

In 2004, the Ohio General Assembly created the Division of Oil and Gas Resources Management within the Ohio Department of Natural Resources ("Division"). The Division has sole and exclusive authority to regulate the permitting, location, and spacing of oil and gas wells and production operations within the state, excepting only those activities regulated under federal laws for which oversight has been delegated to the Ohio Environmental Protection Agency and activities for isolated wetlands permits and discharge of dredging material in wetlands. This included a requirement of uniform statewide regulation and rules adopted under it to constitute a plan with respect to all aspects of locating, drilling, well stimulation, completing, operation of oil and gas wells, within the state, to include site construction, restoration, permitting, and disposal of wastes.

The Ohio Department of Health, Bureau of Environmental Health and Radiation Protection subsequently adopted a TENORM rule for the registration, licensing, and inspection of TENORM users. However, the rule specifically exempted TENORM waste from oil and gas wells and production operations because they are subject to the sole and exclusive regulatory oversight of the Division of Oil and Gas and Resources Management.

As unconventional drilling increased in the Ohio Marcellus and Utica-Point Pleasant shale plays, the Ohio legislature passed a law in September 2013 requiring the owner of horizontal well to provide for the collection and analysis of representative samples of material resulting from the well that is to determine the concentration of radium-226 and radium-228 if the material is TENORM and no exceptions apply to that requirement. For example, testing is not necessary in the material that will be disposed of in a class II injection well or that will be reused in another horizontal well. The Ohio legislature also included in the law a requirement that any person who stores, recycles, treats, processes, or disposes of brine or other waste substances associated with oil and gas exploration, development, well stimulation, production operations, or plugging will be regulated by the Division. These operations are considered as oil and gas waste facilities and must receive authorization from the division to operate.

The Division formed an oil and gas waste facility section, and as a requirement of the authorization to operate, the division requires each operator to implement a radiation protection plan specific to that oil and gas waste facility to address radiological exposure monitoring for staff, the public, and the

environment. For purposes of radiation issues, Division staff consulted with Ohio Department of Health staff through cooperative agreements as allowed under the enacted law.

In 2016, the Division established its own regulatory radiation safety section that is staffed by experienced senior health physicists. The Division's Radiation Safety staff provide plan preparation guidance, conduct acceptance reviews, and inspect oil and gas waste facilities to ensure compliance with the radiation protection plans for that oil and gas waste facility. Agency coordination meetings on oil and gas wastes are held on a routine basis and include staff from the Ohio Department of Health, the Ohio Environmental Protection Agency, the Public Utilities Company of Ohio, and the Ohio Department of Transportation. This helps ensure consistency in regulation of TENORM waste across agency jurisdiction.

On January 13, 2022, the Divisions new oil and gas waste facility rule, Chapter 1501:9-4 of the Ohio Administrative Code, became effective. Currently, a draft oil and gas radiation safety rule is also under internal review. A recent change in state law for rule making has created some challenges in movement of administrative rules forward but the Division continues to pair with affected parties, interested parties, and other agencies while maintaining a proactive approach, ensuring clarity in development, and creating a strong implementation plan.

References

- Code of Colorado Regulations Official Publication of the State Administrative Rules (24-4-103(11) C.R.S.). Hazardous Materials and Waste Management Division. https://www.sos.state.co.us/CCR/NumericalCCRDocList.do?deptID=16&deptName=1000%20Department%20of%20Public%20Health%20and%20Environment&agencyID=141&agencyName=1007%20Hazardous%20Materials%20and%20Waste%20Management%20Division.
- The Ohio Legislature, Ohio Laws & Administrative Rules. Ohio Administrative Code, Rule 1501:9-4, 2022. https://codes.ohio.gov/ohio-administrative-code/chapter-1501:9-4#:~:text=Chapter%201501%3A9%2D4%20%7C%20Oil%20and%20Gas%20Waste%20Facilities&text=Rule%201501%3A9%2D4%2D01%20%7C%20Definitions.&text=(6)%20Any%20alteration%20that%20results,oil%20and%20gas%20waste%20facility.

Jurisdiction and Enforcement with Other Agencies

The U.S. Atomic Energy Act of 1954 excludes diffuse sources of NORM and TENORM. The U.S. EPA currently does not regulate NORM and TENORM, except certain environmental protection programs, such as drinking water standards. So, in most states, the regulatory authority for licensing and inspection of users of NORM and TENORM reside in state Department of Health, Environmental Protection Agency, or Emergency Management Agency, and in many cases, the responsibility for certain aspects may be spread across those agencies. It is crucial that each state establish the intra-department relationships needed to effectively regulate and manage TENORM exposures and disposition. Those regulators should also include their office of general council.

In Ohio, the Department of Health's, Bureau of Environmental Health, and Radiation Protection is the state's radiation control agency. They register, license, and inspect all NORM and TENORM users except TENORM generated from horizontal well oil and gas operations and oil and gas waste facilities. Instead, TENORM from horizontal oil and gas operations and oil and gas waste facilities are regulated by the Ohio Department of Natural Resource's Division of Oil and Gas Resources Management ("Division"). Recognizing that the Division's authority is uniquely cross-jurisdictional, it chairs routine agency coordination meetings related to oil and gas wastes to facilitate open dialogue on jurisdictional concerns, intra-agency regulatory updates, and discussion on current and pending developments related to the Ohio oil and gas wastes regulation. The meetings include representatives from all of the following state agencies: (1) the Division's radiation safety section, oil and gas waste facility section, underground injection control program, emergency operations and response section, and legal; (2) Ohio EPA's Division of Solid Waste, Division of Groundwater and Surface Water, and Office of Emergency Response; (3) Ohio Public Utilities Commissions Hazardous Materials Transport and Enforcement; and (4) Ohio Department of Transportation. This Ohio inter-agency group developed a brine transportation response Standard Operation Procedure (SOP) to allow for the coordination and proper response to brine truck accidents on highways inside of Ohio. The transportation of brine in Ohio can be both intrastate and interstate, therefore, cross-jurisdictional oversight involves multiple state agencies, each with certain established regulatory oversight. The SOP provides a platform to ensure all agencies are working in conjunction with each other with respect to regulatory oversight; including required radiation control for TENORM. The Division has also developed relationships with regulators in its neighboring states of Pennsylvania, West Virginia, Indiana, Kentucky, and Michigan. Because Ohio, Pennsylvania, and West Virginia have oil and gas development in the same shale plays and there is interstate movement of brine and other waste substances, staff of these three state regulatory agencies hold regular meetings to ensure continued discussion and coordination on waste movement, processing, and final disposal.

Strong intrastate and interstate regulatory relationships foster open communication on jurisdictional issues and changes in industry practices and assist with decisions state regulators make to change administrative rules or revise procedures to enhance cross-border jurisdictional enforcement. For example, Division staff worked directly with West Virginia regulators to ensure proper waste profiling and manifesting were being implemented for final disposal of oil and gas wastes at a municipal solid waste landfill. In addition, the Division has developed cross jurisdictional enforcement with federal agencies such as the U.S. EPA, U.S. DOT, U.S. Coast Guard, and the Federal Railroad Administration as a result of requests for transportation of brine and other waste substances by river and railroad.

Both scenarios illustrate the challenges in managing jurisdictional conflicts, the different levels of regulatory enforcement and in determining the appropriate regulatory authority as it pertains to the regulation of TENORM waste. Coordination and open discussion between all agencies involved, allows each agency to work with their respective legal teams to ensure that proper oversight, enforcement, and regulatory authority is in place to ensure the lawful transportation and disposal of TENORM waste occurs.

INTERSTATE Oil & Gas COMPACT COMMISSION

State Summaries for TENORM

ALABAMA

Regulatory agency(s) and jurisdiction(s):
State Oil and Gas Board of Alabama
PO Box 869999
Tuscaloosa, AL 35486-6999
ogb.state.al.us/

Alabama Department of Health, Office of Radiation Control
Administrative Annex, Suite C
P.O. Box 303017
Montgomery, AL 36130-3017
alabamapublichealth.gov/radiation

Relevant statutes/regulations: Rule 400-1-4-316 of the State Oil and Gas Board of Alabama Administrative Code provides in part, "All waste and other material…shall be removed from the location and disposed of in a lawfully approved facility…"

Licensing (generators or commercial activities): No regulations

Remediation of facilities (land and equipment): See relevant statutes/regulations

Disposal of NORM (e.g., downhole, injection, landfill): See relevant statutes/regulations

Monitoring of NORM in drilling, production, processing, transportation, and storage: No regulations

Release, sale or recycle of contaminated land and equipment (owned or leased): See relevant statutes/regulations

Training requirements for operators, surveyors, etc.: No regulations

Recent NORM litigation: None

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: See relevant statutes/regulations

Additional information: None

Respondent: Butch Gregory, Engineering Manager, 205-247-3575

IDAHO

Regulatory agency(s) and jurisdiction(s):
Idaho Department of Lands
300 N. 6th Street, Suite 103
Boise, ID 83702
idl.idaho.gov

Relevant statutes/regulations:
Idaho Statute § 47-3 Oil and Gas Wells- Geologic Information, and Prevention of Waste
https://legislature.idaho.gov/statutesrules/idstat/Title47/T47CH3/
IDAPA 20.07.02 Rules Governing Conservation of Oil and Natural Gas in the State of Idaho
https://adminrules.idaho.gov/rules/current/20/200702.pdf

Licensing (generators or commercial activities): None

Remediation of facilities (land and equipment): None

Disposal of NORM (e.g., downhole, injection, landfill): None

Monitoring of NORM in drilling, production, processing, transportation, and storage: None

Release, sale or recycle of contaminated land and equipment (owned or leased): None

Training requirements for operators, surveyors, etc.: None

Recent NORM litigation: None

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: None

Respondent: James Thum, Program Specialist

Regulatory agency(s) and jurisdiction(s):
Idaho Department of Environmental Quality
Water Quality and Waste Disposal
1410 N. Hilton St.
Boise, ID 83706
deq.idaho.gov

Relevant statutes/regulations:
IDAPA 58.01.10 *Rules Regulating the Disposal of Radioactive Materials*
https://adminrules.idaho.gov/rules/current/58/580110.pdf

Licensing (generators or commercial activities): NA

Disposal of NORM (e.g., downhole, injection, landfill): Not regulated unless deemed source material or by another State agency.

Monitoring of NORM in drilling, production, processing, transportation, and storage: No requirements if NORM. Requirements for monitoring and disposal of TENORM specified in IDAPA 58.01.10.020.01 & 03.

Release, sale or recycle of contaminated land and equipment (owned or leased): Depending on contaminant type, contaminant concentrations, and Responsible Party of the released contaminant, but nothing specific to NORM or TENORM.

Training requirements for operators, surveyors, etc.: None specified by DEQ.

Recent NORM litigation: None

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: See Idaho Department of Lands

Additional information: See Investigation Derived Waste guidance document
https://www2.deq.idaho.gov/admin/LEIA/api/document/download/14978

Respondent: Albert Crawshaw, Hazardous Waste Rules and Policy Coordinator

INDIANA

Regulatory agency(s) and jurisdiction(s):
Indiana Department of Natural Resources
402 West Washington Street
Indianapolis, IN 46204
in.gov/dnr

Relevant statutes/regulations: 312 IAC 29-32; Management of Naturally Occurring Radioactive Material
IC 14-37

Licensing (generators or commercial activities): NA

Remediation of facilities (land and equipment): 312 IAC 29-32-2

Contaminated equipment: An inventory of all NORM contaminated equipment shall be taken to identify the radiation exposure levels, the date the levels were measured, and whether the NORM contaminated equipment is currently in use or located in a designated NORM contaminated equipment storage area awaiting treatment or disposal.

Disposal of NORM (e.g., downhole, injection, landfill): Per 312 IAC 29-32-4, an operator is authorized to dispose of NORM by the following methods:
Downhole disposal is approved during plugging operations provided the norm material is placed at least 250' below the underground source of drinking water.
NORM may be buried on site provided the waste has been treated and meets certain concentration levels; however, burial of NORM contaminated equipment is not authorized.
NORM may be disposed of at the site where the waste is generated by applying it to and mixing it with the land surface, provided the concentration after applying meets certain criteria.
NORM may be disposed of at a waste disposal facility permitted by the Indiana Department of environmental Management or at another state facility if the disposal facility is authorized under license to receive the waste.

Monitoring of NORM in drilling, production, processing, transportation, and storage: A facility considered at risk is responsible for preparing a plan for identifying and determining whether NORM contaminated equipment is present at any of their production operations.

Release, sale or recycle of contaminated land and equipment (owned or leased): NA

Training requirements for operators, surveyors, etc.: Training of personnel on the use of equipment used in identifying NORM contaminated waste is the responsibility of the owner or operator of the well or oil and gas facility.

Recent NORM litigation: None

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: It is common practice to stage all equipment in an area at plugging sites and have one of the state representatives generally the Orphan Well Manager run a Micro R meter on the equipment to determine if it is too much above background to remove from site. Then it is determined how much equipment has NORM if any. Then it is determined how to dispose of it based on what it is and how much there is to dispose of.

Respondent: Brian Royer

KANSAS

Regulatory agency(s) and jurisdiction(s):
Kansas Department of Health and Environment
Bureau of Community Health Services
Radiation Control Program
1000 SW Jackson Suite 330
Topeka, KS 66612
kdhe.ks.gov/1009/Radiation-Right-To-Know

Relevant statutes/regulations: There are no existing regulations specific to NORM. NORM materials are considered radioactive materials by the state of Kansas and subject to radioactive materials licenses if above exempt quantities. Proposed regulations specific to NORM and TENORM are in the development stage.

Licensing (generators or commercial activities): NORM responses are evaluated on a case-by-case basis to decide if a radioactive materials license is required for the material.

Remediation of facilities (land and equipment): Descaling or cleaning operations would require a materials license if the scale or sludge contains non-exempt concentrations and amounts of NORM nuclides such as Ra-226.

Disposal of NORM (e.g., downhole, injection, landfill): There is currently no satisfactory cost-effective method for disposing of NORM or TENORM waste.

Monitoring of NORM in drilling, production, processing, transportation, and storage: There is currently no task force for the monitoring of TENORM in oil production. A preliminary study of drill cuttings in Kansas showed no elevated levels of TENORM.

Release, sale or recycle of contaminated land and equipment (owned or leased): Release of equipment is performed on a case-by-case basis, dependent on the scope of requested activities and amount of contamination. Use of land would require a license. Release of land would require a MARSSIM survey or similar work to show that it meets release criteria present in Kansas Administrative Regulations 28-35-205, 205a, or 205b.

Training requirements for operators, surveyors, etc.: Radiation safety training and equipment training are required for all radiation workers.

Recent NORM litigation: None.

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: There are no specific procedures in place for the plugging of orphan wells from the Radiation Control Program. No well sites have yet to be remediated and would be handled based on the scope of contamination.

Additional information: None.

Respondent: James Uhlemeyer

KENTUCKY

Regulatory agency(s) and jurisdiction(s):
Kentucky Energy & Environment Cabinet
Division of Oil and Gas
300 Sower Blvd
Frankfort, KY 40601
eec.ky.gov/Natural-Resources/Oil-and-Gas

Kentucky Energy & Environment Cabinet
Division of Waste Management
300 Sower Blvd
Frankfort, KY 40601
eec.ky.gov/Environmental-Protection/Waste

Kentucky Cabinet for Health and Family Services
Radiation Health Branch
275 E. Main St. HS1C-A
Frankfort, KY 40621
chfs.ky.gov/agencies/dph/dphps/rhb

Relevant statutes/regulations:
KRS 211.862 - Definitions for KRS 211.861 to 211.869
KRS 211.863 - Control of commerce of low-level radioactive waste in and out of Kentucky; prohibitions; exemption; regulation of TENORM
KRS 211.893 - Legislative findings relating to naturally occurring radioactive material (NORM); required revision of administrative regulations to ensure proper management of oil- and gas-related wastes containing NORM; report to LRC
805 KAR 1:001 - Definitions for 805 KAR Chapter 1
805 KAR 1:060 – Plugging wells
902 KAR 100:180 - Technologically Enhanced Naturally Occurring Radioactive Material related to oil and gas development
401 KAR 48:005 – Definitions for 401 KAR Chapter 48
401 KAR 48:090 – Operating Requirements for Contained Landfills

Section 2. Procedures for Excluding Receipt of Prohibited Wastes → Establishes concentration limits of TENORM that can be disposed of in a contained landfill with reference to 902 KAR 100:180 Section 6(1) and (2).

Section 3. TENORM Waste Disposal from Oil and Gas Development and Production. → Establishes specific requirements for disposal of TENORM.

Licensing (generators or commercial activities): Licensing for storage and treatment of material contaminated with TENORM – see 902 KAR 100:040.

Remediation of facilities (land and equipment): Requires license by Cabinet for Health and Family Services issued pursuant to 902 KAR 100:040.

Disposal of NORM (e.g., downhole, injection, landfill):
902 KAR 100:180

Section 6. Disposal of Wastes

(1)TENORM waste with an activity concentration greater than five and zero-tenths (5.0) and less than or equal to 100 pCi/g of combined Ra-226 and Ra-228 shall be disposed in a:

(a)Landfill meeting the design and construction standards of a contained landfill as established by the Energy and Environment Cabinet that:

1.Possesses a current permit demonstrating compliance with the requirements of KRS 224 and 401 KAR Chapters 47 and 48; and

2.Ensures the disposal is in accordance with statutory provisions of KRS 224 and regulatory provisions of KAR Title 401 that apply specifically to the disposal of TENORM waste in such a facility;

(b)Well that is regulated and permitted for disposal pursuant to the requirements of subsection (4) of this section; or

(c)Landfill meeting the requirements of subsection (2)(a) or (2)(b) of this section.

(2) TENORM waste with an activity concentration greater than 100 and less than or equal to 200 pCi/g of combined Ra-226 and Ra-228 shall be disposed of in a:

(a) Landfill located in Kentucky specifically permitted by the Energy and Environment Cabinet to accept TENORM wastes for disposal or located in Illinois as specified under the terms and conditions of the Central Midwest Interstate Low-Level Radioactive Waste Compact pursuant to KRS 211.859;

(b) Licensed low-level radioactive waste disposal facility as established in 902 KAR 100:021; or

(c) Well that is regulated and permitted for disposal pursuant to 902 KAR 100:180 Section 6(4).

(3) TENORM waste with an activity concentration greater than 200 pCi/g of combined Ra-226 and Ra-228 shall be disposed of in a:

(a) Licensed low-level radioactive waste disposal facility as established in 902 KAR 100:021; or

(b) Well that is regulated and permitted for disposal pursuant to 902 KAR 100:180 Section 6(4).

401 KAR 48:090

Section 3. TENORM Waste Disposal from Oil and Gas Development and Production.

(1) TENORM that meets the criteria established in 902 KAR 100:180, Section 6(1) [TENORM from 5-100 pCi/g] that is to be land disposed shall be disposed:

(a)In a contained landfill permitted in accordance with 401 KAR Chapters 47 and 48 and as authorized by 902 KAR 100:180, Section 6(1)(a); or

(b)As established in subsection (2) of this section as authorized by 902 KAR 100:180, Section 6(1)(c).

(2) TENORM that meets the criteria established in 902 KAR 100:180, Section 6(2) [TENORM from 100-200 pCi/g] that is to be land disposed shall be disposed in a contained landfill permitted in accordance with 401 KAR Chapters 47 and 48 and as authorized by 902 KAR 100:180, Section 6(2)(a) that meets:

(a)The operating requirements established in 902 KAR 100:180; and

(b)Final cap design requirements established in 401 KAR 48:080, Section 8, which shall include both a synthetic liner established in 401 KAR 48:080, Section 9(5) and a low permeability soil layer meeting the design standards in 401 KAR 48:080, Section 8(4) or Section 11.

(3)

(a)A contained landfill shall not accept TENORM waste established in 902 KAR 100:180, Sections 6(1) or 6(2) without having received approval from the cabinet except as established in subsection (b) of this section.

(b)An owner or operator of a contained landfill that possesses a solid waste permit and began accepting TENORM waste established in 902 KAR 100:180, Sections 6(1) or 6(2) before October 1, 2017 and will continue to accept the TENORM waste shall:

1.Manage the TENORM waste in accordance with 902 KAR 100:180 and 401 KAR Chapters 47 and 48;

2.Submit an application for a minor permit modification by July 1, 2018; and

3.Not accept TENORM waste described in 902 KAR 100:180, Sections 6(1) or (6(2) after January 1, 2019, without having received approval from the cabinet of the permit modification required in subparagraph 2. Of this paragraph and paragraphs (c) and (d) of this subsection.

(c)For TENORM waste that complies with the criteria established in 902 KAR 100:180, Section 6(2), the minor permit modification requirements established in 401 KAR 47:130 and paragraph (b)2 of this subsection shall also include:

1.A public notice as established in 401 KAR 47:140, Section 7; and

2.A public comment period of thirty (30) days from the date of public notice to submit written comments on the application.

(d)Upon receipt of an application, the cabinet shall notify the local county government in the county where the disposal of TENORM waste that complies with the criteria established in 902 KAR 100:180, Section 6(2) is proposed.

Exempt from TENORM regulation (902 KAR 100:180): Water produced from or utilized during oil or gas well development or production operations, including produced water and water flowed back following hydraulic fracturing operations that is disposed of in injection wells that are regulated and permitted in accordance with KRS 353.590 through 353.593 and 353.992; 805 KAR 1:110; and, if applicable, the Safe Drinking Water Act, 42 U.SC. 1421 through 1443 and 40 C.F.R. Parts 144 through 147, and Underground Injection Control Program.

Monitoring of NORM in drilling, production, processing, transportation, and storage: Sampling requirements for TENORM waste prior to disposal. Additional sampling may be required after the waste has been prepared or treated to determine disposal method.
See 902 KAR 100:180, generally.

Release, sale or recycle of contaminated land and equipment (owned or leased): An environmental covenant (224.80-100, et. seq) may be required if TENORM waste is released on property that is not a permitted landfill. Other enforcement actions may be necessary on a case-by-case basis. Permitted landfills are required to file a deed notice that more generally notifies future owners that the site has been a solid waste landfill.

Training requirements for operators, surveyors, etc.: See 902 KAR 100:180, Section 9 for worker training and safety requirements on landfills accepting TENORM.

Recent NORM litigation:
DWM-48027 – Concerned Citizens of Estill County Inc. v. EEC and Advanced Disposal Services Blue Ridge Landfill Inc. – CCEC challenged EEC's approval of corrective action plan for TENORM disposal in contained landfill. Parties executed Settlement Agreement that did not amend the corrective action plan, and then filed Joint Agreed Order of Dismissal, which was executed by the Secretary on April 20, 2021

Estill County v Advanced Disposal Services Blue Ridge Landfill, Inc, 16-CI-00163 (Estill Cir. Ct.) – Action related to the same TENORM disposal based on violations of local ordinance. EEC is not a party and has not been following the case. Adv. Disposal's corporate successor has substituted as the Defendant. It appears partial summary judgement in favor of the landfill was granted on January 18,

2022, and an order apparently striking a jury demand was entered on March 10, 2022, and a trial date appears to have been set. There is notation indicating that the case may no longer be on the active docket of the Estill Circuit Court.

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: Please see 805 KAR 1:060 – Plugging wells.

On-site downhole disposal of tubular goods, sludge, and scale containing TENORM shall be allowed by the Division of Oil and Gas in combination with plugging and abandonment of an oil or gas production well if an inspector from the Division of Oil and Gas is present for the duration of the disposal and plugging activity and specific regulatory standards are met. Downhole disposal requires application to and authorization from the Division of Oil and Gas.

Respondent:
Matthew McKinley (CHFS DPH RHB); MatthewW.McKinley@ky.gov,
Dennis Hatfield; dennis.hatfield@ky.gov
Danny J Anderson, (EEC DWM SWB); Danny.Anderson@ky.gov

LOUISIANA

Regulatory agency(s) and jurisdiction(s):
Louisiana Department of Natural Resources
Office of Conservation, Environmental Division
Exploration and Production Waste Management Program
PO Box 94275
Baton Rouge, Louisiana 70804-9275
dnr.louisiana.gov/index.cfm/page/135

Relevant statutes/regulations: The Louisiana Department of Environmental Quality (LDEQ) is Louisiana's primary authorized governing authority for the regulation of Naturally Occurring Radioactive Material (NORM).

La. R.S. 30:4 authorized the Office of Conservation to promulgate regulations for the off-site management of exploration and production waste (E&P Waste). Those regulations are found at: LAC 43:XIX.Subpart 1.Chapter 5 for the Off-Site Storage, Treatment and/or Disposal of Exploration and Production Waste Generated from Drilling and Production of Oil and Gas Wells (Chapter 5). Chapter 5 requirements include 3 specific references to NORM found at the sections detailed below.

§517. Permit Compliance Review A. Commercial facility and transfer station permits shall be reviewed at least once every five years to determine compliance with applicable permit requirements and conditions. Commencement of the permit review process for each commercial facility and transfer station shall proceed as authorized by the Commissioner of Conservation. B. At the commissioner's discretion, any commercial facility or transfer station operator may be required to sample and test facility property and/or equipment for NORM and/or parameters established for "soils" in §549.E.2 to assure compliance with closure requirements of §567.A. The commercial facility or transfer station operator must submit a report detailing the results of all onsite sampling and testing in a manner acceptable to the Commissioner of Conservation. Sampling and testing must be performed by an independent professional consultant and third-party laboratory. Testing must be performed by a DEQ certified laboratory in accordance with procedures presented in the Laboratory Manual for the Analysis of E and P Waste (Department of Natural Resources, August 9, 1998, or latest revision).

§543. Receipt, Sampling and Testing of Exploration and Production Waste A. Only E and P Waste (as defined in §501) from approved generators of record may be received at commercial facilities and transfer stations. Other generators of E and P Waste must receive written approval of the Office of Conservation in order to dispose of approved E and P Waste at a commercial facility or transfer station. B. For screening purposes and before offloading at a commercial facility or transfer station, each load of E and P Waste shall be sampled and analyzed (by facility personnel) for the following parameters: 1. pH, electrical conductivity, chloride (Cl) content; 2. NORM, as required by applicable DEQ regulations and requirements. C. The commercial facility or transfer station operator shall enter the pH, electrical

conductivity, and chloride (Cl) content on the manifest (Form UIC-28, or latest revision) which accompanies each load of E and P Waste. D. An 8-ounce sample (minimum) of each load must be collected and labeled with the date, operator and manifest number. Each sample shall be retained for a period of 30 days. E. Records of these tests performed pursuant to the requirements of this Section shall be kept on file at each facility for a period of three years and be available for review by the commissioner or his designated representative.

§565. Resource Conservation and Recovery of Exploration and Production Waste A. In order to encourage the conservation and recovery of resources in the oilfield industry, the processing of E and P Waste into reusable materials or FSR fluid, in addition to or beyond extraction and separation methods which reclaim raw materials such as crude oil, diesel oil, etc., is recognized as a viable alternative to other methods of disposal. Title 43, Part XIX 61 Louisiana Administrative Code November 2021 B. Commercial facilities may function for the purpose of generating reusable material or FSR fluid only, or they may generate reusable material or FSR fluid in conjunction with other storage, treatment or disposal operations. C. Commercial facilities that generate reusable material or FSR fluid are subject to all of the permitting requirements imposed on other commercial facilities. They are also subject to the same operational requirements without regard to the distinction between E and P Waste and reusable material or FSR fluid. Existing permits may be amended to allow re-use or FSR fluid operations at commercial facilities which acquire the capability to engage in processing for reuse or FSR fluid operations. Commercial facilities which utilize extraction or separation methods to reclaim raw materials such as crude oil, diesel oil, etc. may do so without amendment of existing permits. D. The onsite generation of reusable material by oil and gas operators, pit treating companies or other companies which do not hold a legal commercial facility permit is prohibited unless the company desiring to perform such activities complies with the requirements of this Subparagraph and submits the following information to the commissioner for approval: 1. the names, addresses, and telephone numbers of the principal officers of the company; 2. a detailed description of the process by which the company will treat pit fluids and/or solids (E and P Waste), including the types of chemicals and equipment used in the process, diagrams, test data, or other information; 3. a description of the geographical area in which the company expects to do business (i.e., statewide, north Louisiana, southwest Louisiana, etc.). E. In addition to other applicable requirements, companies seeking to be permitted for the production of reusable materials from E and P Waste shall have the following obligations. 1. Prior to permit approval or permit amendment approval, applicants must submit the following information: a. a detailed description of the process to be employed for generation of reusable material; b. type of treatment system and/or equipment to be constructed (or added); c. identification of the proposed uses for the reusable material; and d. a description of the proposed monitoring plan to be utilized. 2. All proposed uses of reusable material must be approved by the commissioner in writing. 3. The production of reusable material must be conducted in accordance with a monitoring plan approved by the commissioner with issue of the permit for each facility or process. 4. For purposes of regulatory authority only by the Office of Conservation and the establishment of reusable material, compliance with the testing criteria of §565.F below allows permitted companies to offer the material for the following uses: a. daily cover in sanitary landfills which are properly permitted by state and/or local authorities. The use of reusable material in a sanitary landfill will require written approval of the Department of Environmental Quality; and b. various types of construction material (fill) on a case-by-

case basis. The commissioner may approve such use only after submission and review of an application for the intended use. Approval will be dependent upon the composition of the material and the proposed location of use. Reusable material may not be used as fill for construction purposes unless the specific use has been approved in writing by the Commissioner of Conservation. F. Testing Criteria for Reusable Material Parameter Limitation Moisture Content < 50% (by weight) or zero free moisture pH* 6.5 - 9.0 Electrical Conductivity (EC) 8 mmhos/cm Sodium Adsorption Ratio (SAR) 12 Exchangeable Sodium Percentage (ESP) 15% Total Barium: Reuse at Location other than Commercial facility 40,000 ppm Leachate Testing** for: TPH Chlorides 10.0 mg/l 500.0 mg/l TCLP Benzene 0.5 mg/l Leachate Testing**: Arsenic Barium Cadmium Chromium Copper Lead Mercury Molybdenum Nickel Selenium Silver Zinc 0.5 mg/l 10.0 mg/l 0.1 mg/l 0.5 mg/l 0.5 mg/l 0.5 mg/l 0.02 mg/l 0.5 mg/l 0.5 mg/l 0.1 mg/l 0.5 mg/l 5.0 mg/l NORM Not to exceed Applicable DEQ Criteria/Limits *E and P Waste when chemically treated (fixated) shall, in addition to the criteria set forth be acceptable as reusable material with a pH range of 6.5 to 12 and an electrical conductivity of up to 50 mmhos/cm, provided such reusable material passes leachate testing requirements for chlorides in §565.F above and leachate tests for metals in §565.F above. **The leachate testing method for TPH, chlorides and metals is included in the Laboratory Manual for the Analysis of E and P Waste (Department of Natural Resources, August 9, 1988, or latest version). G. A reuse stockpile management plan shall be included in the E and P Waste management and operations plan and as a minimum, shall include the following: NATURAL RESOURCES Louisiana Administrative Code November 2021 62 1. dust emissions controls for loading, transporting and offloading operations; 2. erosion control techniques; and 3. optimum pile height and slope. H. The Commissioner of Conservation, the Secretary of the Department of Natural Resources, and the State of Louisiana upon issuance of a permit to a company or commercial facility under this Section shall be held harmless from and indemnified for any and all liabilities arising from the operation of such facilities and use of their products, and the company shall execute such agreements as the commissioner requires for this purpose. I. Reporting. Each company which generates reusable material must furnish the commissioner a monthly report showing the disposition of all such material. J. Onsite temporary use of E and P Waste for hydraulic fracture stimulation operations is permissible only as authorized by the Office of Conservation and in accordance with the requirements of LAC 43:XIX.313.J. K. Existing commercial facilities who desire to commence FSR fluid operations must comply with the notification, application and permitting requirements of LAC 43:XIX.519. L. The Commissioner of Conservation, the Secretary of the Department of Natural Resources, and the State of Louisiana upon issuance of a permit to a commercial facility operator for FSR fluid operations shall be held harmless from and indemnified for any and all liabilities arising from such operations and use of FSR fluid, and the commercial facility operator shall execute such agreements as the commissioner requires for this purpose. M. Reporting. Each commercial facility which generates FSR fluid must furnish the commissioner a monthly report showing the disposition of all such material.

Licensing (generators or commercial activities): As licensed, approved or permitted by LDEQ.

Remediation of facilities (land and equipment): As approved by LDEQ.

Disposal of NORM (e.g., downhole, injection, landfill): For non-injection or downhole, as approved by LDEQ.

Monitoring of NORM in drilling, production, processing, transportation, and storage: As required by LDEQ and as required in the above Chapter 5 regulations.

Release, sale or recycle of contaminated land and equipment (owned or leased): As required by LDEQ.

Training requirements for operators, surveyors, etc.: As required by LDEQ.

Recent NORM litigation: Not aware of any including the Office of Conservation, Environmental Division.

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: Contact Office of Conservation, Engineering Division.

Additional information: In addition, there are two disposal options for NORM under Conservation's Injection and Mining Program.

1. Slurry Fracture Injection. The regulations begin on page 34, Article 433.
   http://www.dnr.louisiana.gov/assets/OC/Rules/43v19_April2019.pdf#page=34

   The application is designated as UIC-2 SFI COM and can be found at:
   http://www.dnr.louisiana.gov/assets/docs/conservation/documents/uic02comsfi.pdf

2. NORM encapsulation by plugging and abandoning a well bore. The plugging regulations begin on page 14, Article 137.
   http://www.dnr.louisiana.gov/assets/OC/Rules/43v19_April2019.pdf#page=34
   The application is designated as UIC-30 Work Permit to Plug & Abandon a Well utilized for NORM disposal. http://www.dnr.louisiana.gov/assets/docs/conservation/documents/uic30.pdf

(For additional information on disposal options, contact Steve Lee Stephen.lee@la.gov 225-342-5569.)

Respondent:
Gary W. Snellgrove, Director
Environmental Division
Office of Conservation
Louisiana Department of Natural Resources
Gary.Snellgrove@la.gov
225-342-7222

Regulatory agency(s) and jurisdiction(s):
Louisiana Department of Environmental Quality
Emergency and Radiological Services Division
Radiation Section
PO Box 4312
Baton Rouge, LA 70821
deq.louisiana.gov/subhome/emergency-response

Relevant statutes/regulations: LAC 33:XV.Chapter 14

Licensing (generators or commercial activities): LAC 33:XV.Chapter 14

Remediation of facilities (land and equipment): LAC 33:XV.Chapter 14

Disposal of NORM (e.g., downhole, injection, landfill): LAC 33:XV.Chapter 14

Monitoring of NORM in drilling, production, processing, transportation, and storage: LAC 33:XV.Chapter 14

Release, sale or recycle of contaminated land and equipment (owned or leased): LAC 33:XV.Chapter 14

Training requirements for operators, surveyors, etc.: LAC 33:XV.Chapter 14

Recent NORM litigation: None recent.

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: LAC 33:XV.Chapter 14 and https://www.deq.louisiana.gov/assets/docs/Forms/RPD-34-NORM-Disposal-in-a-Well-to-be-PA-06.doc

Additional information:
https://www.deq.louisiana.gov/assets/docs/Forms/RPD-35-NORM-Temp-Jobsite-Not-08-11.pdf
https://www.deq.louisiana.gov/assets/docs/Forms/PDF-RPD-36-NORM-Site-Not-Form-06.pdf
https://www.deq.louisiana.gov/assets/docs/Forms/RPD-37-NORM-Manifest-06.pdf
https://www.deq.louisiana.gov/assets/docs/Forms/RPD-38-P-A-Questionnaire-06.pdf
https://www.deq.louisiana.gov/assets/docs/Radiation/LDEQ-Manual-for-Management-of-NORM-FINAL.pdf
https://www.deq.louisiana.gov/assets/docs/Forms/NORM-release-criteria-1-11.pdf
https://www.deq.louisiana.gov/assets/docs/Forms/RAM-NORM-Specific-Lic-Guide-11.pdf

MICHIGAN

Regulatory agency(s) and jurisdiction(s):
Department of Environment, Great Lakes, and Energy
Materials Management Division
Radiological Protection Section
michigan.gov/egle/about/organization/materials-management/radiological

Department of Environment, Great Lakes, and Energy
Oil, Gas, and Minerals Division
Field Operations Section
michigan.gov/egle/about/organization/oil-gas-and-minerals

Relevant statutes/regulations:
Act No. 688, Public Acts of 2018
Act No. 689, Public Acts of 2018
Act No. 368 Part 135 Public Health Code, Public Acts of 1978
Michigan's Ionizing Radiation Rules
Natural Resources and Environmental Protection Act Act No. 451 of the Public Acts of 1994, as amended
Part 615, Supervisor of Wells and the Administrative Rules
Part 616, Orphan Well Fund
Part 625, Michigan's Mineral Well Operation Regulations

Licensing (generators or commercial activities): Registration is required by Radiological Protection Section for companies whose business involves, but not limited to, the processing, down-blending, and cleaning of land and equipment with TENORM. Registration conditions may be required by the Radiological Protection Section depending on the scope of registration. Generators of TENORM are not required to register with the Radiological Protection Section. EQP 1614 Radioactive Material Registration

Remediation of facilities (land and equipment): Oil, Gas, and Minerals Division Closure Guidelines for Radiological Soil Surveys and Removal
Michigan's guidelines for site cleanup and disposal of sites contaminated with TENORM, EQC-1602

Disposal of NORM (e.g., downhole, injection, landfill): Disposal of TENORM at landfills in Michigan is regulated by the following Public Acts:
Act No. 688, Public Acts of 2018
Act No. 689, Public Acts of 2018
Supervisor of Mineral Wells Instruction 1-92
Supervisor of Wells Instruction1-2002, Amended
Supervisor of Wells Order 3-6-92

Monitoring of NORM in drilling, production, processing, transportation, and storage:
Not regulated by Radiological Protection Section.

OGMD Monitors TENORM levels for wells, facilities, and flowlines.

Release, sale or recycle of contaminated land and equipment (owned or leased): Unrestricted release of land and equipment fall subject to the following:
Michigan's Ionizing Radiation Rules
Michigan's guidelines for site cleanup and disposal of sites contaminated with TENORM, EQC-1602

Training requirements for operators, surveyors, etc.: Training is required for radioactive registrants pursuant to Michigan's Ionizing Radiation Rules Part 5 – Standards for Protection Against Radiation.

Recent NORM litigation: None

What NORM procedures does your state follow in plugging orphan wells and remediating well sites:
Michigan's guidelines for site cleanup and disposal of sites contaminated with TENORM, EQC-1602
Supervisor of Mineral Wells Instruction 1-92
Supervisor of Wells Instruction1-2002, Amended
Supervisor of Wells Order 3-6-92

Oil, Gas, and Minerals Division Closure Guidelines for Radiological Soil Surveys and Removal

Additional information: None

Respondent:
Jay Paquette – Radioactive Materials Unit Supervisor
paquettej3@michigan.gov, 517-243-7197
Radiological Protection Section
Materials Management Division
Department of Environment, Great Lakes, and Energy

Rick Henderson – Field Operations Manager
Hendersonr2@michigan.gov 231-631-7078
Oil, Gas, and Minerals Division
Department of Environment, Great Lakes, and Energy

MISSISSIPPI

Regulatory agency(s) and jurisdiction(s):
Mississippi State Oil & Gas Board
500 Greymont Avenue, Suite E
Jackson, MS 39212
ogb.state.ms.us

Relevant statutes/regulations: Rule 68 & 69

Licensing (generators or commercial activities): Prohibited, see Rule 68.V.3.

Remediation of facilities (land and equipment):
Land – Rule 68.6.b.ii., Rule 69.6.ii.(2)
Equipment – Rule 68.7

Disposal of NORM (e.g., downhole, injection, landfill):
Rule 68.II., through VII.

1. Placement between cement plugs; or
2. Encapsulation in pipe then placed between cement plugs; or
3. Mixed with gel or mud (slurried) and placed between cement plugs; or
4. Slurried then placed into a formation; or
5. Surface landspreading; or
6. Subsurface landspreading; or
7. Disposal offsite at a licensed, low level radioactive waste or NORM disposal facility;
8. Any options other than those listed above will be evaluated for possible approval by the State Oil & Gas Board Technical staff.

Monitoring of NORM in drilling, production, processing, transportation, and storage:
Drilling – Rule 69.3.f.
Production – Rule 69.3.g.- 5.c.
Processing – NA
Transportation – Rule 68.II.3.
Storage – Rule 68.I.4., Rule 69.2.dd.

Release, sale or recycle of contaminated land and equipment (owned or leased):
Land – Rule 69.6
Equipment – Rule 69.7

Training requirements for operators, surveyors, etc.: Rule 69.2.aa.

Recent NORM litigation: NA

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: MSOGB requires a well site to meet Rule 69.6 and – Rule 69.7 release and remediation criteria.

Additional information:
Rule 68 –Form 20 – Work Permit to Plug and Abandon Well Utilized for NORM Disposal – https://www.ogb.state.ms.us/forms/Form20.pdf
Rule 68 – Form 2 – Application to Drill, Workover or Change of Operator – https://www.ogb.state.ms.us/forms/Form2.pdf
Rule 68 – Downhole Disposal – Form 6 – https://www.ogb.state.ms.us/forms/Form6.pdf
Rule 69 – Form 21 – Radiation Survey for Oil Field NORM – https://www.ogb.state.ms.us/forms/Form21.pdf

Respondent:
David Snodgrass, RPG
Geologist Team Lead/ UIC Coordinator

MISSOURI

Regulatory agency(s) and jurisdiction(s):
Missouri Department of Natural Resources
Waste Management Program
1730 E. Elm St.
PO Box 176
Jefferson City, MO 65102-0176
dnr.mo.gov/about-us/division-environmental-quality/waste-management-program

Relevant statutes/regulations:
https://www.sos.mo.gov/cmsimages/adrules/csr/current/10csr/10c80-3.pdf
https://revisor.mo.gov/main/OneSection.aspx?section=260.392

Licensing (generators or commercial activities): Not regulated by WMP.

Monitoring of NORM in drilling, production, processing, transportation, and storage: This is not regulated as far as the oil and gas industry is concerned. NORM is allowed to be disposed of in landfills as a special waste with a determination letter from the WMP.

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: This is not regulated as far as the oil and gas industry is concerned.

Respondent:
Aaron Szapa – Geologist
Missouri Geological Survey
573-508-3175
Aaron.szapa@dnr.mo.gov

MONTANA

Regulatory agency(s) and jurisdiction(s):
Montana Department of Environmental Quality
1520 E 6th Ave.
Helena, MT 59601
deq.mt.gov

Relevant statutes/regulations:
https://rules.mt.gov/gateway/Subchapterhome.asp?scn=17%2E50.18
https://leg.mt.gov/bills/mca/title_0750/chapter_0100/part_0020/sections_index.html

NEBRASKA

Regulatory agency(s) and jurisdiction(s):
Nebraska Oil and Gas Conservation Commission
1625 Dorwart Drive
Sidney, NE 69162
nogcc.ne.gov

Relevant statutes/regulations: Statues Chapter 57, Rules Title 267 (NOGCC has no written rules regarding TENORM).

Licensing (generators or commercial activities): NA

Remediation of facilities (land and equipment): NA

Disposal of NORM (e.g., downhole, injection, landfill): NA

Monitoring of NORM in drilling, production, processing, transportation, and storage: NA

Release, sale or recycle of contaminated land and equipment (owned or leased): NA

Training requirements for operators, surveyors, etc.: NA

Recent NORM litigation: None

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: Can be done as per the oil and gas inspector's directions.

Additional information: Although NOGCC has no written rules or guidelines, field operations that have TENORM considerations can be conducted to protect worker health and safety.

Respondent:
Stan Belieu
Director, Nebraska Oil and Gas Conservation Commission

NEVADA

Regulatory agency(s) and jurisdiction(s):
Department of Public Health and Human Services Division of Public and Behavioral Health Radiation Control Program
675 Fairview Drive, Suite 218
Carson City. NV 89701
dpbh.nv.gov/Reg/Radiation_Control_Programs

Relevant statutes/regulations:
NRS 459 and NAC 459

Currently, NORM and TENORM have limited regulations and are not addressed in oil and gas activities. The Radiation Control Program is working with other state programs, agencies, and committees to develop a more comprehensive set of regulations for the increase risks due to water, oil, gas, and mineral exploration.

Licensing (generators or commercial activities): Types – General, Specific, and Broad, however none specific to oil and gas activities.

Remediation of facilities (land and equipment): Only generally addressed in terms of decommissioning of a facility, requires plan for financing and bonding – NAC 459.1955

Disposal of NORM (e.g., downhole, injection, landfill): Not specifically addressed.

Monitoring of NORM in drilling, production, processing, transportation, and storage: None

Release, sale or recycle of contaminated land and equipment (owned or leased):
Not specifically addressed.

Training requirements for operators, surveyors, etc.:
Only addressed for well logging – NAC 459.3153

Recent NORM litigation: None known.

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: NA

Additional information: NAC 459.184 Exemption for certain concentrations and quantities of radioactive material other than source material. (NRS 459.030, 459.201)

1. Except as otherwise provided in subsection 3, any person is exempt from NAC 459.180 to 459.3154, inclusive, to the extent that he or she receives, possesses, uses, transfers, owns or acquires products or materials containing:

(a) Radioactive material in concentrations not in excess of those listed in NAC 459.186; or
(b) Naturally occurring radioactive material that contains less than 5 picocuries (0.185 becquerels) of radium-226 per gram of material.

Respondent:
Mike Visher, Nevada Division of Minerals
mvisher@minerals.nv.gov

NEW MEXICO

Regulatory agency(s) and jurisdiction(s):
Energy, Minerals & Natural Resources Department, Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
emnrd.nm.gov/ocd

New Mexico Environment Department, Radiation Control Bureau
1190 St. Francis Drive, Suite N4050
Santa Fe, New Mexico 87505
env.nm.gov/rcb

Relevant statutes/regulations:
19.15.35.9 NMAC through 19.15.35.14 NMAC; Waste Disposal
https://www.srca.nm.gov/wp-content/uploads/attachments/19.015.0035.pdf

20.3.14 NMAC; Naturally Occurring Radioactive Materials in the Oil and Gas Industry
https://www.srca.nm.gov/wp-content/uploads/attachments/20.003.0014.pdf

Licensing (generators or commercial activities):
Disposal of regulated NORM on or near the surface of the ground is done pursuant to a general license issued by the New Mexico Environment Department. Before a commercial or centralized facility may accept regulated NORM for treatment and/or disposal, the operator of the facility must obtain both a specific license issued by the New Mexico Environment Department and a surface waste management facility permit from the Oil Conservation Division.

Remediation of facilities (land and equipment): Soil - <30 picocuries per gram of Radium 226 and <150 picocuries per gram for all other radionuclides. Equipment - <50 microroentgens per hour

Disposal of NORM (e.g., downhole, injection, landfill):
Downhole – Allowed in a plugged and abandoned well with Oil Conservation Division approval at a depth of at least 100 feet below the lower most known underground source of drinking water. There must be evidence that there is cement across that drinking water zone. A cement plug dyed with red iron oxide must be placed directly above the NORM and at the surface.

Injection – For injection into a Underground Injection Control (UIC) Class I or II disposal well, only NORM from the operator's operations can be injected with approval from the Oil Conservation Division and into a zone at least 100 feet below the lower most known underground source of drinking water. Each time NORM is injected, the Oil Conservation Division must be notified. For injection into a UIC Class II enhanced recovery well, injection can occur only after notice and a hearing wherein the applicant must demonstrate that the injection will not reduce the ultimate recovery of hydrocarbons and will not cause an increase in the level of NORM from a producing well located either within or offsetting the project area.

Landfill – There currently are no landfills in New Mexico with the proper license or permit for the acceptance of regulated NORM.

Non-retrieved flowlines and pipelines – Allowed with approval from the Oil Conservation Division and an explanation as to why it is more beneficial to leave the pipeline in place than retrieve it. Such approval will be conditioned upon the flushing of hydrocarbons and produced water from the pipe, proof of notice to the surface owner(s), and all accessible points being permanently capped. No additional NORM may be placed into the pipe other than that which accumulated during normal operations.

Monitoring of NORM in drilling, production, processing, transportation, and storage: Persons subject to a general license must undertake radiation surveys of equipment and facilities in their control or possession and maintain that information on file. Surveys must be conducted prior to working on facilities or equipment where a potential release of NORM could occur or where workers could be exposed, prior to any transfer of equipment or salvage, prior to equipment removal from any facility, where pipe has been cleaned, or at facilities where materials are known to have been spread, spilled, or stockpiled. These surveys must be conducted using proper equipment and by knowledgeable personnel.

Release, sale or recycle of contaminated land and equipment (owned or leased): No facility can be transferred where the concentration of Radium 226 in soil exceeds 30 picocuries per gram above background. The landowner must be notified prior to mixing of soils. Facilities and equipment containing regulated NORM cannot be released for unrestricted use, but they can be transferred provided the facilities or equipment are to be used for the same or similar purpose. Equipment containing regulated NORM may be released for maintenance or overhaul provided the recipient is specifically licensed to perform such activity.

Training requirements for operators, surveyors, etc.: There are currently no specific NORM training requirements for operators or surveyors.

Recent NORM litigation: There has been no recent litigation in New Mexico concerning NORM in the oil and gas industry.

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: The Oil Conservation Division adheres to our NORM-related regulations when plugging orphan wells and remediating orphan well sites. All materials removed from wells (sucker rods, tubing, etc.) and surface infrastructure (tanks, heater treaters, separators, etc.) are surveyed for the presence of regulated NORM before disposal or salvage.

Additional information: None

Respondent:
Jim Griswold, Oil Conservation Division
505-660-1067, jim.griswold@state.nm.us

NEW YORK

Regulatory agency(s) and jurisdiction(s):
Department of Environmental Conservation
Division of Mineral Resources, Bureau of Oil & Gas Permitting and Management
Jurisdiction: Oil, Gas and Solution Mining
625 Broadway, Albany, New York 12233-6500
dec.ny.gov/energy/205.html

Department of Environmental Conservation
Division of Materials Management, Bureau of Hazardous Waste and Radiation Management
Jurisdiction: Radioactive Materials
625 Broadway, Albany, New York 12233-7256
dec.ny.gov/chemical/8498.html

Relevant statutes/regulations: 6 NYCRR Part 360 Series – Solid Wastes (Notably, Part 363 – Landfills). 6 NYCRR Part 380 – Rules and Regulations for Prevention and Control of Environmental Pollution by Radioactive Materials.
Link to 6 NYCRR Part 360 Series and Part 380: https://www.dec.ny.gov/regs/2491.html.

Licensing (generators or commercial activities): The Department of Environmental Conservation ("DEC") is not a radioactive materials licensing agency. The licensing agencies in New York State (State Health Department and New York City Health Department) have not required licenses for NORM from oil and gas production.

Remediation of facilities (land and equipment): DEC has cleanup guidelines for soils contaminated with radioactive materials (DER-38). In the near future, DEC will adopt federal regulations for the remediation of such soils.
Link to DER-38: https://www.dec.ny.gov/regulations/23472.html.

Disposal of NORM (e.g., downhole, injection, landfill): NORM-containing solid wastes (e.g., drill cuttings, dewatered mud) are not regulated radioactive wastes and may be disposed of in landfills regulated under 6 NYCRR Part 360. The concentration limit for such wastes is 25 pCi/g Ra-226. Flowback water and production brine may be injected into permitted disposal wells with prior approval, although the use of disposal wells in New York is limited. TENORM wastes (e.g., processed and concentrated NORM-containing wastes) are regulated radioactive wastes per 6 NYCRR Part 380 and may not be disposed of in landfills regulated under 6 NYCRR Part 360. TENORM wastes may be disposed of in certain out-of-state RCRA C facilities (there are no RCRA C facilities in New York) or low-level radioactive waste disposal sites.
Link to 6 NYCRR Parts 360 Series and 380: https://www.dec.ny.gov/regs/2491.html.

Monitoring of NORM in drilling, production, processing, transportation, and storage: Monitoring of NORM for these activities is not required by DEC.

Release, sale or recycle of contaminated land and equipment (owned or leased): DEC has cleanup guidelines for soils contaminated with radioactive materials (DER-38). DEC does not regulate the sale of NORM-contaminated land.
Link to DER-38: https://www.dec.ny.gov/regulations/23472.html.

Training requirements for operators, surveyors, etc.: DEC does not require training for site workers.

Recent NORM litigation: DEC is not aware of recent NORM litigation.

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: There are no prescribed NORM procedures for plugging orphan wells and remediating related well sites. A 1999 study by DEC shows that NORM-containing wastes at sites comparable to orphan well sites pose no risk to public health or the environment.
Report Link (DEC NORM Study): https://www.dec.ny.gov/chemical/23473.html.

Additional information: None

Respondent: Eric Rodriguez

NORTH DAKOTA

Regulatory agency(s) and jurisdiction(s):
North Dakota Industrial Commission
Oil and Gas Division
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840
dmr.nd.gov/oilgas

North Dakota Department of Environmental Quality
4201 Normandy Street
Bismarck, ND 58503-1324
deq.nd.gov

Relevant statutes/regulations: Solid Waste Management and Land Protection Rules - NDAC 33.1.20 – North Dakota Department of Environmental Quality (nd.gov)

Licensing (generators or commercial activities):
Treating Plant - NDAC 43-02-03-51 -> nd1.ac_web (ndlegis.gov)
Regulation and Licensing of TENORM - NDAC 33.1-10-23-10 -> 33.1-10-23.pdf (nd.gov)
Financial assurance arrangements - NDAC 33.1-10-23-25 -> 33.1-10-23.pdf (nd.gov)
Application for radioactive material license -> North Dakota Department of Environmental Quality Application for Radioactive Materials Licence (nd.gov)
Application for TENORM transporter radioactive material license -> Microsoft Word - General Radioactive Material License Application (nd.gov)

Remediation of facilities (land and equipment):
Treating Plant - NDAC 43-02-03-51 -> nd1.ac_web (ndlegis.gov)
Radioactive Waste Disposal of Equipment - NDAC 33.1.20-11-01 -> North Dakota Administrative Code - Title 33.1 Article 20 Chapter 11 (ndlegis.gov)

Disposal of NORM (e.g., downhole, injection, landfill):
Underground Injection Control - NDAC 43-02-05 -> North Dakota Administrative Code - Title 43 Article 2 Chapter 5 (ndlegis.gov)
Disposal and transfer of waste for disposal - NDAC 33.1-10-23-08 -> 33.1-10-23.pdf (nd.gov)
Landfill Disposal - NDAC 33.1-20-11-01 -> North Dakota Administrative Code - Title 33.1 Article 20 Chapter 11 (ndlegis.gov)

Monitoring of NORM in drilling, production, processing, transportation, and storage:
DEQ monitors TENORM through regular inspections of processing and storage locations.
Disposal and transfer of waste for disposal - NDCC 33.1-10-23-08 -> 33.1-10-23.pdf (nd.gov)
Landfill Disposal - NDAC 33.1-20-11-01 -> North Dakota Administrative Code - Title 33.1 Article 20 Chapter 11 (ndlegis.gov)

Release, sale or recycle of contaminated land and equipment (owned or leased): This does not apply.

Training requirements for operators, surveyors, etc.: Radiation safety officer – Qualifications - NDAC 33.1-10-23-28 -> 33.1-10-23.pdf (nd.gov)

Recent NORM litigation: There has been none.

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: Plugging orphan wells follows typical well plugging procedures. Operators must properly dispose of any equipment or soil contaminated with TENORM at an approved location. Soil is to be sampled for possible contamination.
List of approved locations -> Waste Management - North Dakota Department of Environmental Quality (nd.gov)

OHIO

Regulatory agency(s) and jurisdiction(s):
Ohio Department of Natural Resources
Division of Oil & Gas Resources Management
2045 Morse Rd. – F3
Columbus, OH 43229
ohiodnr.gov/discover-and-learn/safety-conservation/about-odnr/oil-gas/oil-gas

Relevant statutes/regulations: The Ohio Department of Natural Resources Division of Oil and Gas Resources Management (Division) is authorized to regulate Ohio's oil and gas industry in Ohio Revised Code Section 1509.02. This statute provides the Division "sole and exclusive authority to regulate the permitting, location, and spacing of oil and gas wells and production operations…" The statute goes on to state that the regulation of oil and gas is a matter of statewide interest, and the Division's regulatory framework provides a comprehensive plan that governs all aspects of the industry from spacing, locating, and construction of wells to the disposal of wastes associated with those wells. The definition of "production operations" is broad and encompasses all aspects of oil and gas activity in Ohio.
Two exceptions to the Division's sole and exclusive jurisdiction over oil and gas operations do exist related to technologically enhanced radioactive material (TENORM): the Ohio Department of Health retains authority to regulate TENORM scale in oil and gas pipe cleaning (OAC 3701:1-43-07 (I)); and the Ohio Environmental Protection Agency has authority over the disposal of oil and gas wastes containing TENORM in licensed solid waste landfills (ORC 3734.02 (P)).

Licensing (generators or commercial activities): The Division permits and regulates oil and gas waste facilities (OAC 1501:9-4). The rules (OAC 1501:9-4-01) defines TENORM and lists seven specific oil and gas waste types that are TENORM. OAC 1501:9-4-04 (C)(3)(b)(vi) requires applicants for a permit to construct a waste facility to include a radiation protection plan with their application documents. OAC 1501:9-4-06 states that no oil and gas TENORM wastes can be accepted or removed from a waste substance facility without a manifest that identifies it as NORM or TENORM. The rule goes on to state that if the waste is TENORM pursuant to the definition, then the manifest must also indicate if the waste is less than or greater than 7.0 pCi/g of Ra226 & Ra228 and must include a copy of the laboratory analytical results.

Remediation of facilities (land and equipment): OAC 1501:9-4-07 contains specific oil and gas waste facility closure and reclamation requirements.

Disposal of NORM (e.g., downhole, injection, landfill): The Division has no NORM/TENORM testing or monitoring requirements for downhole/ injection of brine or other waste substances. The Ohio General Assembly specifically exempts (ORC 1509.074) testing of brine or other waste substances for TENORM if the waste is to be disposed of into an underground injection control well. Ohio EPA has a solid waste landfill disposal of TENORM statute that requires Ra226 & Ra228 testing and establishes maximum permissible concentrations for TENORM disposal. (ORC 3734.02 (P)).

Monitoring of NORM in drilling, production, processing, transportation, and storage: Ohio law (ORC 1509.074) contains Ra226 & Ra228 testing requirements for shipment of TENORM wastes from horizontal wells. Horizontal wells are defined in Ohio as wells drilled to produce from the Utica, Pt. Pleasant, and Marcellus formations. Wells drilled into other formations, no matter the orientation of the well, and their associated production facilities do not have NORM/TENORM testing or monitoring requirements. Waste processing activities must occur at a permitted oil and gas waste facility, which has requirements listed in the permitting section. Testing or monitoring for NORM/TENORM is required when brine or other wastes are transported to or from a permitted oil and gas waste facility. Testing or monitoring for NORM/TENORM of wastes in storage is a requirement of a permitted oil and gas waste facility.

Release, sale or recycle of contaminated land and equipment (owned or leased): OAC 1501:9-4-07 contains specific oil and gas waste facility closure and reclamation requirements. OAC 1501:9-3-07 (I) requires operators of Class II Disposal Wells to lawfully dispose of waste, including used pipe and fittings. The Division is currently drafting Radiation Safety Rules that will build on its authority to ensure lawful disposal of equipment.

Training requirements for operators, surveyors, etc.: In 2016, the Division established a Radiation Safety Section staffed with experienced health physicists to enforce Ohio's regulatory authority and educate the oil and gas industry. The Division is currently drafting Radiation Safety Rules that will build on this statutory authority by establishing basic radiation safety protections/requirements and enhancing the requirements of radiation protection plans.

Recent NORM litigation: None

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: On orphan well plugging projects completed using state funds, Division Radiation Safety Section Health Physicists perform a pre-plugging radiological assessment of each well site to determine if radiological control measures will be needed during plugging activities. Regardless of the results, all metal materials removed for salvage during any plugging project must be radiologically screened for acceptance by the Division prior to removal from the project site.

Respondent: Chuck McCracken, 614-265-6672

OKLAHOMA

Regulatory agency(s) and jurisdiction(s):
Oklahoma Corporation Commission
Oil and Gas Conservation Division
2101 North Lincoln Blvd.
Oklahoma City, OK 73105
oklahoma.gov/occ/divisions/oil-gas.html

Relevant statutes/regulations: Oklahoma does not regulate TENORM waste generated during oil and gas production.

Licensing (generators or commercial activities): DEQ
https://www.deq.ok.gov/land-protection-division/radiation/radiation-management/

Remediation of facilities (land and equipment): No regulations/statutes governing oilfield TENORM management or cleanup.

Disposal of NORM (e.g., downhole, injection, landfill): OCC rules 165:10-11-8 Procedures for identification and control of wellbores in which radioactive sources have been abandoned.
DEQ reference: https://www.deq.ok.gov/land-protection-division/radiation/radiation-management-disposal-information/ deals with general regs of disposal of rad waste primarily other than oilfield waste. Oklahoma Administrative Code (OAC) 252:515-19-31. Prohibited Wastes

(a) Hazardous, radioactive, regulated PCB waste. The disposal of any quantity of hazardous, radioactive, or regulated polychlorinated biphenyl (PCB) waste at a solid waste disposal facility is prohibited.

Monitoring of NORM in drilling, production, processing, transportation, and storage: No monitoring requirements in our rules.

Release, sale or recycle of contaminated land and equipment (owned or leased): Not OGCD jurisdiction.

Training requirements for operators, surveyors, etc.: Not OGCD jurisdiction.

Recent NORM litigation: NA

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: OCC rules 165:10-11-8 Procedures for identification and control of wellbores in which radioactive sources have been abandoned.

Respondent: This survey was completed by Virginia Hullinger (Virginia.hullinger@occ.ok.gov) and Steven Carlson. (Steven.Carlson@occ.ok.gov)

PENNSYLVANIA

Regulatory agency(s) and jurisdiction(s):
Pennsylvania Department of Environmental Protection
Bureaus of Radiation Protection, Waste Management, and Oil & Gas
400 Market Street
Harrisburg, PA 17101
dep.pa.gov

Relevant statutes/regulations: Given there is a low potential to exceed the 100 mrem/yr public dose limit, DEP does not directly license NORM / TENORM under its Radiation Protection regulations. However, given the volumes of waste generated by the O&G industry, the potential for spills and releases during O&G well development, the Bureaus of Waste Management and Oil & Gas regulations require the development and implementation of a Radiation Protection Action Plan. Those Plans are reviewed by the Bureau of Radiation Protection.

Authority and details of Pennsylvania laws and regulations can be found in: the Solid Waste Management Act, Act of July 7, 1980, P.L. No. 97, as amended, 35 P.S. §§ 6018.101 – 6018.1003 (SWMA); the Radiation Protection Act, Act of July 10, 1984, P.L. 688, No. 147, 35 P.S. §§ 7110.101 – 7131.703; the Clean Streams Law, Act of June 22, 1937, P.L. 1987, Art. I §1, as amended, 35 P.S. §§ 691.1 – 691.1001; 2012 Oil and Gas Act, Act of February 14, 2012, P.L. 87, No. 13, 58 Pa. C.S. §§ 3201 – 3274; and Section 1917-A of the Administrative Code, 71 P.S. 510.17; Municipal and Residual Waste Regulations, 25 Pa. Code, Chapters 271 – 299; Radiological Health Regulations, 25 Pa. Code, Chapters 215 – 240; Oil and Gas Regulations, 25 Pa. Code §§ 78a.58 (relating to onsite processing), and 78.18 (related to disposal well permits); and Water Resources Regulations, 25 Pa. Code § 91.34 (relating to activities utilizing pollutants).

The Solid Waste and O&G regulations cited above note a DEP technical guidance document for developing and implementing a Radiation Protection Action Plans. This TGD was last published in 2004, but was recently updated and published in 2022. This report TDG is posted online at – https://www.dep.pa.gov/Business/RadiationProtection/RadiationControl/Radioactive-Material-In-Solid-Waste-Monitoring/Pages/default.aspx

Licensing (generators or commercial activities): No radiation protection licensing of generators or commercial activities related to NORM / TENORM, however Solid Waste and O&G operations and facilities are 'permitted' by DEP [see regs noted above].

Remediation of facilities (land and equipment): The TDG noted above and posted online reviews and presents a table of Applicable or Relevant and Appropriate Requirements (ARARs) for radiological surveys and release of soils, building structures and equipment contaminated with radium, uranium, thorium and other NORM.

Disposal of NORM (e.g., downhole, injection, landfill): Per our regulations and TGD, much O&G TENORM waste is disposed of in the Commonwealth's RCRA D landfills, but in recent years, a significant volume has been shipped for disposal at licensed low-level radioactive waste (LLRW) disposal sites in UT and TX. There are only a few injection wells available in-state for O&G wastewater disposal.

Monitoring of NORM in drilling, production, processing, transportation, and storage: The TDG noted above and posted online reviews the need for monitoring of: O&G drilling, production, waste processing, transportation, and storage of NORM / TENORM. DEP also has a fact sheet on proper DOT transport of TENORM. See –
http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=35372&DocName=SHIPPING%20OF%20TECHNOLOGICALLY%20ENHANCED%20NATURALLY%20OCCURRING%20RADIOACTIVE%20MATEIRAL%20UNDER%20THE%20U.S.%20DOT%20HAZARDOUS%20MATERIAL%20TRANSPORTATION%20REGULATIONS.PDF%20%20%3cspan%20style%3D%22color:green%3b%22%3e%3c/span%3e%20%3cspan%20style%3D%22color:blue%3b%22%3e%28NEW%29%3c/span%3e%201/8/2022

Release, sale or recycle of contaminated land and equipment (owned or leased): NORM or TENORM contaminated land or equipment would require decontamination prior to release, sale or recycle.

Training requirements for operators, surveyors, etc.: The TDG noted above.

Recent NORM litigation: Sayreville Seaport Associate v. PA DEP
https://www.pacourts.us/assets/opinions/Commonwealth/out/2391cd11_2-14-13.pdf

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: Under review.

Additional information: The Commonwealth of Pennsylvania has a single agency [the Department of Environmental Protection] that permits activities and facilities related to Oil & Gas well development, Waste Management and Radiation Protection. As noted in the circa 1999 IOGCC NORM Guidance, DEP had done radiological survey work in the early 1990s at several hundred conventional O&G well sites, pipe yards, and roads treated with brines. Survey results published in the mid-1990s illustrating brines could have several thousands of picocuries per liter of radium-228 and -226, but the authors concluded there was no significant hazard to the environment, public and workers. This report is posted online at –
https://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/RadiationProtection/NORM.pdf

In the circa 2010 timeframe the unconventional O&G drilling and well development operations began to out-number conventional well permits. Given the millions of gallons of water used to hydro-fracture tight shale formations to release trapped natural gas [in PA], the high TDS associated with flow-back water, and reports of highradium content of the used fracwater, the DEP undertook an expansive study

of NORM/TENORM. The results of this study were published in final form in May 2016. This report and all related data are also posted online at – https://www.dep.pa.gov/Business/Energy/OilandGasPrograms/OilandGasMgmt/Oil-and-Gas-Related-Topics/Pages/Radiation-Protection.aspx

http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=5815&DocName=01%20PENNSYLVANIA%20DEPARTMENT%20OF%20ENVIRONMENTAL%20PROTECTION%20TENORM%20STUDY%20REPORT%20REV%201.PDF%20

It was concluded there was a low potential for workers or members of the public to receive radiation exposure above the 100 millirem per year public dose limit, but there was potential for contamination of the environment from spills. Further evaluation of landfill TENORM waste disposal, road brine spreading, pigging operations, and some wastewater treatment operations was warranted.

Numerous guidance documents available from the ASTSWMO, CRCPD, IAEA and NCRP.

Respondent:
David J. Allard, MS, CHP
Director, Bureau of Radiation Protection
PA Dept. of Environmental Protection
Phone: 717.787.2480

SOUTH DAKOTA

Regulatory agency(s) and jurisdiction(s):
South Dakota Department of Agriculture and Natural Resources
Waste Management Program
523 East Capitol Ave
Pierre SD 57501
danr.sd.gov/Environment/WasteManagement

Relevant statutes/regulations: South Dakota Codified Law (SDCL) 34A-6-114. Law went into effect July 1, 2013.

Licensing (generators or commercial activities): NA

Remediation of facilities (land and equipment): NA

Disposal of NORM (e.g., downhole, injection, landfill): TENORM wastes which have been generated during oil and gas production activities with a total laboratory-measured radioactivity level of Radium-226 plus Radium-228 greater than 5 picocuries/gram above the background radioactivity level of a permitted municipal solid waste landfill, are prohibited from being disposed of at a municipal solid waste landfill. TENORM wastes that are below background radioactivity levels plus 5 picocuries/gram of combined Radium-226 plus Radium-228 are allowed for disposal at a municipal solid waste landfill. No other facilities in SD are allowed to dispose of TENORM wastes from oil and gas activities.

Monitoring of NORM in drilling, production, processing, transportation, and storage: NA

Release, sale or recycle of contaminated land and equipment (owned or leased): NA

Training requirements for operators, surveyors, etc.: Department has developed guidance documents for TENORM generators and municipal solid waste landfill operators to follow regarding proper sampling techniques and frequency of sampling protocols for the disposal of TENORM wastes.

Recent NORM litigation: None

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: NA

Additional information: Only two of the 15 municipal solid waste landfills have conducted background radioactivity soil sampling to establish background radioactivity levels. If a municipal solid waste landfill does not establish background radioactivity levels, its assumed that background levels are 0 picocuries/gram.

Soil Sampling and Analysis Procedure for
Permitted MSW Landfill Operators Accepting Contaminated Soil
From the Oil and Gas Industry
March 4, 2015 (updated April 11, 2022)

South Dakota Codified Laws 34A-6-114 requires laboratory-measured radioactivity levels of Radium-226 plus Radium-228 for oil and gas wastes. Municipal solid waste landfills (MSWs) are not allowed to accept any oil and gas generated wastes for disposal or use as daily cover, if the laboratory measured radioactivity is greater than 5 picocuries/gram above the background radioactivity level at the landfill. All radioactivity levels must be measured using methods and procedures approved by the South Dakota Department of Agriculture and Natural Resources (DANR).

The following are procedures written and approved by DANR.

Radium-226 and Radium-228 concentrations in oil and gas waste impacted soil must be determined by the generator /transporter of the waste prior to the contaminated soil arriving at the permitted MSW. No soil is allowed to be accepted if sampling results, provided by the generator/transporter, exceeds 5 picocuries/gram of Radium-226 plus Radium-228 radioactivity over background conditions. No amount of soil can be accepted without laboratory results and documentation that procedures for the generator/transporter were followed. At a minimum, at least one different representative laboratory result must be provided by the generator/transporter for every 100 tons of impacted soil delivered to the landfill. A representative composite sample result and documentation is required even when the tonnage from a single source or well site is less than 100 tons.

The following documentation from the generator/transporter must accompany every truckload/container of contaminated soil:

1. Written documentation of procedures that were followed to collect and analyze samples (a copy of the third party environmental firm's written report);

2. A copy of the laboratory results for Radium-226 and Radium-228 from a certified EPA or certified State laboratory;

3. Written documentation with the name of the company transporting the soil, and the date and time soil was accepted at the landfill. The transporter must advise the operator when the 100 ton limit is reached for a single source or well site.

Landfill Verification Sampling

The landfill operator must also sample soil coming into the landfill to verify the results provided by the generator/transporter. This is to confirm soils coming into the landfill are not significantly different than results received from the generator/transporter. A composite random sample must be collected by the landfill operator (or other designated individual) for every 250 tons of soil accepted for disposal or daily cover. Do not confuse the "every 250 tons" of soil you are responsible for sampling, with the "every 100 tons" of soil the generator/transporter is responsible for sampling. Verification sampling does not need to be completed more than every 250 tons unless verification sample results are significantly different than the generator/transporter sample results or verification sample results exceed the limit of 5 picocuries/gram of Radium-226 plus Radium-228 above background.

The following is the procedure to use for verification sampling conducted by the landfill operator (or designated individual):

1. Check with a certified laboratory first for the volume of soil needed to test for radium, what type of containers to use (lab personnel will likely supply containers to you), how to package and ship the samples, and procedures for their chain-of-custody process. This is important.

2. Use a sampling tool (i.e., stainless steel trowel or shovel) to collect 4 samples of contaminated soil from one randomly selected dumped truckload of soil in four different spots within the soil pile. You must do this for every 250 tons accepted. The 4 samples can be collected at any time within the 250 ton window. Random means there is not an established pattern for selecting a truckload. Document the date, time, name of person sampling, name of generator/transporter. Record this information for the file.

3. Place the 4 soil samples in a clean 1-gallon sealable plastic bag. Seal the bag and knead the soil so that it's thoroughly mixed. This is called compositing a sample (referred to as a composite sample). Fill the sample container the laboratory has either provided or has asked you to use, with the mixed soil. Label the sample in a unique way so you will know what sample result is attributed to what truckload. For example – sample # 2014 – 1 XYZ (stands for the company name), representing the first composite sample collected in 2014. Use your imagination.

4. The stainless steel trowel or shovel used to sample soil must be cleaned before each composite sample is collected. The trowel or shovel may be cleaned using a soft-bristle scrub brush and a nonphosphate detergent solution. The equipment should be rinsed with distilled or deionized water and dried with paper towels.

5. Arrange for shipment of the composite sample according to the certified laboratory's instructions. Make sure the chain-of-custody forms are properly filled out (these should be available from the laboratory and they can help you fill out the forms). The soil must be tested for Radium-226 and Radium-228 using any EPA approved laboratory method or any method approved of in writing by the DANR-Waste Management Program. The quick count method, Modified EPA method 901.1M, has been approved of in writing for use in measuring Radium 226 and Radium 228 for this protocol.

6. Add the Radium-226 and Radium-228 from the laboratory results sheets for each composite sample. This will give you the total Radium result. The total Radium result cannot be greater than 5 picocuries per gram above the established background at the landfill. Call DANR Waste Management Program immediately if total Radium results are greater than 5 picocuries per gram above background. Compare your laboratory results with the results provided to you at the gate from the generator/transporter (be sure you are comparing the correct results for both the sample you took and the sample results provided to you at the gate). If these results are significantly different from each other, consult with the DANR Waste Management Program. All information required by this procedure must be kept on-site and made available for DANR review upon request.

The above procedure is written for contaminated soil from drill cuttings taken to a permitted MSW for disposal or daily cover only. Other waste streams may need a different written protocol. Please contact DANR– Waste Management Program at 605-773-3153, if you have any questions or you need a protocol for a different type of waste stream.

Procedure to Determine Acceptance of
Contaminated Soil from Oil and Gas Activities at
South Dakota Permitted MSW Landfills
March 4, 2015 (updated April 11, 2022)

South Dakota Codified Laws 34A-6-114 requires laboratory-measured radioactivity level of Radium-226 plus Radium-228 for oil and gas wastes. Municipal solid waste landfills (MSWs) are not allowed to accept any oil and gas generated wastes for disposal or use as daily cover, if the laboratory measured radioactivity is greater than 5 picocuries/gram above the background radioactivity level at the landfill. All radioactivity levels must be measured using methods and procedures approved by the South Dakota Department of Environment and Natural Resources (DANR). The following are the procedures approved by DANR.

Radium concentrations in oil and gas waste impacted soil must be determined for every source or well site prior to the contaminated soil arriving at the permitted MSW. Random representative composite soil samples must be taken for every 100 tons of soil delivered to the landfill. A representative composite sample is required even when the tonnage from a single source or well site is less than 100 tons. Procedures for collection of representative random samples are described in an EPA document known as SW-846. The specific reference for sampling procedures is Volume II, Part III, Chapter 9 of SW-846 – Test Methods for Evaluating Solid Wastes Physical/Chemical Methods found at the following website: http://www.epa.gov/epawaste/hazard/testmethods/sw846/pdfs/chap9.pdf. This EPA document is the DANR approved procedure for sample collection. Any deviation from these procedures must be approved of in writing by DANR- Waste Management Program.

A third party firm experienced in environmental sampling procedures must be used to collect soil samples. Third party firm is defined as an independent firm that is not directly affiliated with any of the parties generating, storing, transporting, disposing or otherwise managing the contaminated soil. An

approved method for analysis of radium in soil samples is any EPA approved laboratory method for Radium-226 and Radium-228 or a method approved of in writing by DANR-Waste Management Program. Written approval has been given for the use of a quick count method known as Modified 901.1M for this written protocol. Soil samples must be sent to an EPA or state certified laboratory.

Before samples are sent to a certified laboratory for analysis, the third party firm must contact lab personnel to get instructions on the amount of soil needed to test for radium, what type of containers to use, how to package and transport the samples, procedures for their chain-of-custody process and anything else the laboratory may require. This is important. Third party environmental firms may already know the process for the particular laboratory conducting the analysis.

Written documentation that these procedures were followed (third party firm's written report) and laboratory results for Radium-226 and Radium-228 must accompany every shipment (truck/container) of contaminated soil from oil and gas activities disposed in South Dakota permitted landfills. Remember, sample results must be representative of every 100 tons of contaminated soil brought to the landfill. Written documentation must also be provided to the landfill operator when the 100 ton limit is reached. The operator will then expect different written reports and laboratory analysis documenting the next 100 tons.

Contact DANR-Waste Management Program at 605-773-3153 if you have questions about acceptance of any type of oil and gas waste for disposal in South Dakota.

Respondent: Steven Kropp

TEXAS

Regulatory agency(s) and jurisdiction(s):
The Railroad Commission of Texas
PO Box 12967
Austin, Texas 78711-2967
rrc.texas.gov

Relevant statutes/regulations:
In accordance with Tex. Water Code (TWC) Ann. §26.131 (1), the Railroad Commission of Texas (the commission) is solely responsible for the control and disposition of waste and the abatement and prevention of pollution of surface and subsurface water resulting from activities associated with the exploration, development, and production of oil or gas or geothermal resources. Tex. Nat. Res. Code (TNRC) Ann. §91.101 further authorizes the commission to adopt and enforce rules and orders to prevent pollution of surface water or subsurface water in the state.
NORM Rule
https://texreg.sos.state.tx.us/public/readtac$ext.ViewTAC?tac_view=5&ti=16&pt=1&ch=4&sch=F&rl=Y

Licensing (generators or commercial activities): RRC does not have a licensing program. Refer to Texas Department of State Health Services (DSHS) 25 TAC §289.259(d) for information relating to Licensing of Naturally Occurring Radioactive Material (NORM).

Remediation of facilities (land and equipment): Oil and gas NORM waste is defined as any solid, liquid, or gaseous material or combination of materials (excluding source material, special nuclear material, and by-product material) that spontaneously emits radiation in its natural physical state, is discarded or unwanted, constitutes, is contained in, or has contaminated oil and gas waste, and exceeds the exemption criteria specified in 25 Texas Administrative Code §289.259(d)(1)(B) and (d)(2) prior to treatment or processing that reduces the radioactivity concentration.

Remediation of NORM waste and affected soils is typically performed by removing and relocating the affected materials to a properly permitted disposal facility, utilizing properly permitted waste haulers. Confirmation sampling is performed to determine that all materials remaining in place do not exceed exemption criteria. Onsite burial or landfarming at the generating location is authorized by rule provided that sampling demonstrates concentrations of radium 226 combined with radium 228 are below 30 pCi/g and any other NORM radionuclide is below 150 pCi/g.

NORM waste may be buried or landspread at a location other than the generating location after obtaining a permit to do so from RRC. Radium 226 combined with radium 228 must be below 30 pCi/g and any other NORM radionuclide is below 150 pCi/g, just as for burying or landfarming at the generating location. All NORM contaminated equipment must be tagged. Decontamination of equipment can occur, and this typically involves removing scale from pipes or NORM wastes from other surface equipment so that readings exceeding 50 µR/hr are no longer measured. NORM scale or sludge

that is removed from equipment should be properly disposed of per requirements of 16 TAC §4.614-§4.623. NORM contaminated equipment may not be buried.

Disposal of NORM (e.g., downhole, injection, landfill): Disposal options for Oil and Gas NORM are described in §4.614- §4.623. at the link below.

Monitoring of NORM in drilling, production, processing, transportation, and storage: Anyone who owns or operates equipment used for production or disposal (including waste storage tanks) must identify NORM-contaminated equipment with the letters "NORM" by securely attaching a clearly visible waterproof tag or marking with a legible waterproof paint or ink. Employers whose employees speak languages other than English may add to the tag the translation of the acronym "NORM" in those languages as long as the acronym "NORM" is also on the tag.

Disposal facilities with oil and gas surface waste disposal permits that require financial security are required to conduct a NORM screening survey of the facility when submitting a closure cost estimate (CCE) for permit renewal. If NORM is detected at the facility above the screening level, the CCE must include additional costs for disposal of NORM-contaminated equipment, soils, or waste.

The DSHS regulates the possession, use, transfer, transport, and storage of NORM.

Release, sale or recycle of contaminated land and equipment (owned or leased):
Land: The RRC's Voluntary Cleanup Program and Brownfield Response Program are available to eligible property owners who wish to sell or reuse contaminated land to ensure that NORM wastes are properly disposed of, and oil field contamination, including NORM contaminated soils, is properly assessed and cleaned up.

Equipment: All NORM-contaminated equipment must be tagged. NORM contaminated equipment can be sold or salvaged for use for the same or original purpose for which it was intended. For example, NORM-contaminated tubing can be used as tubing, not for fence posts or in a cattle guard. NORM-contaminated equipment that is waste, such as equipment that is no longer wanted, may be decontaminated and recycled as scrap metal under DSHS regulations.

Training requirements for operators, surveyors, etc.: Decontamination requires a NORM contractor with a trained Radiation Safety Officer (RSO) supervising activity.

Recent NORM litigation: None

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: A NORM field survey using a properly calibrated scintillator is performed at oil and gas sites to identify equipment, waste and areas of contaminated soil with radioactivity elevated above background. Materials with radioactivity exceeding twice background are sampled and tested for radium 226, 228, and other radionuclides to determine if they are NORM wastes.

Scintillators should be calibrated once per year. All NORM-contaminated equipment must be tagged. Field staff receive HAZWOPER 24-hour and 8-hour training which includes a module on NORM.

Additional information: None

Respondent: Peter G. Pope, P.G., Manager, Site Remediation, 512-463-8202

Regulatory agency(s) and jurisdiction(s):
Texas Department of State Health Services
Radiation Control Program
Environmental Monitoring Group, Radiation Surveillance, Surveillance Section
PO Box 149347
Austin, Texas 78714-9347
dshs.state.tx.us/radiation

Relevant statutes/regulations: §289.102 Memorandum of Understanding Between the Department of State Health Services and the Railroad Commission of Texas Regarding Radiation Control Functions , 25 TEXAS ADMINISTRATIVE CODE §289.201 General Provisions for Radioactive Material, §289.202 Standards for Protection Against Radiation from Radioactive Materials, §289.204 Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services, §289.259 (TRCR Part 46) Licensing of Naturally Occurring Radioactive Material (NORM)

Licensing (generators or commercial activities): https://www.dshs.state.tx.us/radiation/ram/norm.aspx

Disposal of NORM (e.g., downhole, injection, landfill): The Texas Natural Resource Conservation Commission (TNRCC) has the jurisdiction to regulate disposal of NORM, other than oil and gas NORM, which is under the jurisdiction of the Railroad Commission of Texas (RCT).

VIRGINIA

Regulatory agency(s) and jurisdiction(s):
Virginia Department of Energy
3405 Mountain Empire Road
Big Stone Gap, Virginia 24219
energy.virginia.gov

Relevant statutes/regulations: No regulations pertaining to handling or disposal of NORM have been established in Virginia. A study of NORM in shale gas source rocks from Virginia published in August of 2017 concluded that these organic shale rocks are unlikely to cause harmful radiation exposure above normal background levels - Lassetter, William L., 2017, Analysis of Naturally Occurring Radioactive Materials (NORM) in Shale Gas Source Rocks from Virginia: Division of Mineral Resources Open File Report 2017-01, 84 p.

Licensing (generators or commercial activities): No licensing requirements for the handling or disposal of NORM have been established in Virginia.

Remediation of facilities (land and equipment): No NORM contamination of facilities has been detected in Virginia that would necessitate remediation.

Disposal of NORM (e.g., downhole, injection, landfill): No NORM have been detected in Virginia that would necessitate special disposal requirements.

Monitoring of NORM in drilling, production, processing, transportation, and storage: The need to monitor for NORM has not been established in Virginia.

Release, sale or recycle of contaminated land and equipment (owned or leased): No NORM contamination of land or equipment has been detected in Virginia.

Training requirements for operators, surveyors, etc.: No NORM have been detected in Virginia that would necessitate special training requirements.

Recent NORM litigation: None

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: No conditions have been detected in Virginia that would necessitate NORM procedures in plugging orphan wells and remediating well sites.

Respondent: Blair Linford, Gas and Oil Compliance/Permitting Specialist

WEST VIRGINIA

Regulatory agency(s) and jurisdiction(s):
West Virginia Department of Environmental Protection
Division of Water and Waste Management
601 57th Street SE
Charleston, WV 25304
dep.wv.gov/howdoi/Pages/dwwm.aspx

West Virginia Department of Health and Human Resources
Office of Environmental Health Services
350 Capitol Street, Room 313
Charleston, WV 25301-3713
oehs.wvdhhr.org

Relevant statutes/regulations:
Code of State Rules Title 33, Series 1 (33CSR1) (DWWM)
Code of State Rules Title 33, Series 1A (33CSR1A) (DWWM)
Code of State Rules Title 64, Series 23 (64CSR23) (OEHS)

Disposal of NORM (e.g., downhole, injection, landfill):
33CSR1-5.6
33CSR1A
64CSR23-16

Monitoring of NORM in drilling, production, processing, transportation, and storage:
33CSR1-5.6
33CSR1A
64CSR23-16

Training requirements for operators, surveyors, etc.:
33CSR1-5.6.d.

What NORM procedures does your state follow in plugging orphan wells and remediating well sites: There are no additional specific requirements related to well plugging.

Respondent: James Martin, WVDEP, Office of Oil and Gas

WYOMING

Regulatory agency(s) and jurisdiction(s):
Wyoming Oil and Gas Conservation Commission
2211 King Blvd
PO Box 2640
Casper WY, 82602
wogcc.wyo.gov

Relevant statutes/regulations: Chapter 4, Section 4 (a)(x) - Dispose of produced water, tank bottoms, and other miscellaneous solid waste in a manner which is in compliance with the Commission's rules and other state, federal, or local regulations.

Additional information: Also regulated by Wyoming Department of Environmental Quality in certain circumstances.

Respondent: Tom Kropatsch

Regulatory agency(s) and jurisdiction(s):
Wyoming Department of Environmental Quality
200 West 17th St.
Cheyenne, WY 82002
deq.wyoming.gov

Relevant statutes/regulations: The WDEQ Solid Waste Permitting and Corrective Action Program does not have regulations specific to NORM. Industrial and municipal solid waste landfills accept waste streams from the oil and gas industry that could contain NORM. These types of landfills are issued operating permits and regulated under Solid Waste Rules Chapter 1: General Provisions, Chapter 2: Municipal Solid Waste Landfill Regulations, and Chapter 3: Industrial Landfill Regulations. A copy of these regulations can be found on the Wyoming Secretary of State webpage at https://rules.wyo.gov/Search.aspx?mode=1

Solid Waste Guideline #24: *Naturally Occurring Radioactive Material (NORM) Management in Wyoming* provides guidance and recommendations on how best to handle NORM containing waste material for disposal. A copy of this guideline can be found on the WDEQ webpage under Guidance and Standards at https://deq.wyoming.gov/shwd/solid-waste/

Disposal of NORM (e.g., downhole, injection, landfill): Industrial and municipal solid waste landfills must obtain an operating permit. These permitted landfills may accept waste streams from the oil and gas industry.

Additional information: During 2020-2021, WDEQ hired a third-party consultant to prepare the Technologically Enhanced Naturally Occurring Radioactive Material Evaluation Report (Report). The purpose of this Report was to investigate and develop a further understanding of the presence and concentration of TENORM in oil and gas industry waste streams within Wyoming. The Report included an evaluation of other states TENORM regulations, current research by laboratories and institutions, sampling of oil and gas industries wastes, and evaluation of the collected samples. The Report included general recommendations on the management of TENORM wastes in Wyoming.

The study concluded in June of 2021 with more than 80 samples from oil and gas facilities who voluntarily participated across five of the eight oil and gas basins in Wyoming. The waste streams sampled included filter socks, gas filtration, pipe scale, tank solids, settling ponds solids, drill cuttings, and outfall solids. Elevated levels above background of TENORM were identified in the tank solids, pipe scale, and outfall solids waste streams.
WDEQ plans to review and revise the Solid Waste Guideline #24: *Naturally Occurring Radioactive Material (NORM) Management in Wyoming* as appropriate.

Respondent: Jody Weikart – Solid Waste Permitting and Corrective Action Program Manager

Appendix A: Additional References

- Allard, David J., 2019, Introduction to Radiation Protection and NORM. "Cradle to Grave" NORM Management Workshop, The Ninth International Symposium on NORM (NORM IX). https://nucleus.iaea.org/sites/orpnet/home/Shared%20Documents/S1-Allard-Cradle%20to%20Grave%20NORM%20Management.pdf
- Allard, David J. and Lombardo, Andrew J., 2019, Findings of the PA Oil & Gas TENORM Study. The Ninth International Symposium on NORM (NORM IX). https://nucleus.iaea.org/sites/orpnet/home/Shared%20Documents/T2-Allard-TENORM-Study-USA.pdf
- Association of State and Territorial Solid Waste Management Officials (ASTSWMO) Federal Facilities Research Center's Radiation Focus Group, 2014, State Regulations and Policies for Control of Naturally-Occurring and Accelerator Produced Radioactive Materials (NARM) and Technologically Enhanced Naturally-Occurring Radioactive Materials (TENORM). http://astswmo.org/files/policies/Materials_Management/State_Statutes_and_Regulations_TENORM_Final_Dec2014.pdf
- Bilak, Roman, 2019, Achieving Zero-Discharge NORM Waste Disposal Using Slurry Fracture Injection (SFI) Technology. The Ninth International Symposium on NORM (NORM IX). https://nucleus.iaea.org/sites/orpnet/home/Shared%20Documents/T1-Bilak-Zero-Discharge-NORM-Disposal-Canada.pdf
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- Desrosiers, Arthur, Techniques for Indistinguishable from Background Surveys. Jacobs Engineering Group. https://nucleus.iaea.org/sites/orpnet/home/Shared%20Documents/T2-Desrosiers-Background-Surveys-USA.pdf
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