



## 1.0 ACTIVITY DESCRIPTION AND PURPOSE

- 1.1 This is a document for Natural Gas Transmission and Storage.
- 1.2 This document provides basic health, safety, and environmental guidelines related to Naturally Occurring Radioactive Material (NORM) and Technologically Enhanced Naturally Occurring Radioactive Material (TENORM). This document is intended as a reference for Radiation Safety Officers (RSO) and Environmental Health and Safety (EHS) Officers.

*Note: Throughout this document, the acronym NORM will be used to represent both NORM and TENORM interchangeably.*

- 1.3 The management of oil-and-gas related NORM should conform to regulations found in Title 10 CFR, Part 20, Standards for Protection against Radiation and/or State NORM regulations. The guidelines presented in this document do not supersede or replace regulatory requirements, nor are they intended to be all inclusive of the applicable regulatory requirements. Instead, they are intended to be supportive and complementary to such requirements.

## 2.0 DEFINITIONS

*Note: See Appendix B for "What is NORM?"*

For the purposes of this document, the following terms shall have the meanings set forth in this section. The terms "shall", "will" and "must" indicate mandatory requirements. The terms "should", "could" or "may" indicate that the action or methodology is highly preferred or recommended.

**Accessible Point** - An external location on a piece of equipment or place in a facility where NORM may be present.

**Activity Level** - A level in picocuries/gram determined by collecting a sample and sending it to a radiological laboratory for analysis.

**Agreement State** - A state that has entered into an agreement with the U.S. Nuclear Regulatory Commission under subsection 274b of the Atomic Energy Act of 1954, as amended (68 Stat. 919), to assume responsibility for regulating within its borders byproduct, source, or special nuclear material in quantities not sufficient to form a critical mass.

**Airborne Contamination** - Contamination that is suspended in air

**ALARA** - Acronym for the phrase "As Low As Reasonably Achievable". It is most often used in reference to chemical or radiation exposure levels

**ALI** - Acronym for the phrase "Annual Limit on Intake". Derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year



**Alpha Particle** - A positively charged particle that consists of two protons and two neutrons bound together. It is emitted by an atomic nucleus undergoing radioactive decay and is identical to the nucleus of a helium atom. Because of the irrelatively large mass, alpha particles are the slowest and least penetrating forms of nuclear radiation. They can be stopped by a piece of paper

**Background Radiation** - Radiation from cosmic sources; naturally occurring radioactive materials, including radon, except as a decay product of source or special nuclear material, and including global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents, such as Chernobyl, that contribute to background radiation

**Beta Particle** - A high-speed electron or positron, usually emitted by an atomic nucleus undergoing radioactive decay. Beta particles are given off naturally by decaying neutrons in radioactive atoms and can be created in particle accelerators. Beta particles have greater speed and penetrating power than alpha particles but can be stopped by a sheet of aluminum that is 2 to 3mm thick

**Confirmatory Survey** - A survey of potentially contaminated land, equipment, or sites in order to establish, with reasonable certainty, the absence or magnitude of NORM contamination.

**Contamination Survey** - A use of swipes or direct instrument surveys to identify and quantify radioactive material on equipment or on personnel

**Counts per minute (cpm)** - The number of radioactive decays per minute detected by an instrument.

**DAC** - Acronym for the phrase "Derived Air Concentration". The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (with an inhalation rate of 1.2 cubic meters of air per hour), results in an intake of one annual limit on intake (ALI)

**Date of Generation** - A date of the first addition of waste into the container

**Decontamination** - A cleaning process of removing NORM contaminants from equipment, tubulars, or facilities to reduce levels of radiation. Note: In states with NORM-specific regulation, a "Specific License" is required to do this work. Requirements are many and onerous and many natural gas transmission companies choose not to decontaminate in order to avoid the requirements. Such companies often hire contractor companies that hold a Specific License for the state in question, which can conduct NORM decontamination work.

**Disintegrations per minute (dpm)** - The number of radioactive decays per minute taking place within the material.



**Effluent** - Gas and/or liquid that flows from a process, building, or site into the surrounding environment.

**Exposure** - Being exposed to ionizing radiation or to radioactive material

**Exposure Rate** - The exposure per unit of time, such as Roentgen per minute (R/min) and milliroentgen per hour (mR/hr).

**Fixed Contamination** - Contamination that cannot be removed from surfaces by casual contact but may be released when the surface is disturbed. For example, by grinding, drilling, or cleaning with volatile liquids. Over time, fixed contamination may weep, leach, or otherwise become removable

**Frisking**- Conducting a whole-body survey for contamination is called frisking. Frisking is generally done on yourself using the appropriate type of contamination monitoring equipment called a frisker

**Gamma Ray** - A stream of high-energy electromagnetic radiation given off by an atomic nucleus undergoing radioactive decay. Because the wavelengths of gamma rays are shorter than those of x-rays, gamma rays have greater energy and penetrating power than x-rays. Gamma rays are emitted by pulsars, quasars, and radio galaxies but cannot penetrate the Earth's atmosphere

**General License** - A license issued to mine, extract, receive, possess, own, use, process, and transfer NORM not exempt in the NORM Exemption Limits topic without regard to quantity. General Licenses are authorized by rule and all companies handling NORM work under a general license even if a document or license is not issued by a federal or state agency.

**Ionizing Radiation** - Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter. It includes any or all of the following: alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles, but not sound or radio waves, or visible, infrared, or ultraviolet light

**Loose Contamination** - Also known as **Transferable** or **Removable Contamination**, is contamination that can be readily removed from surfaces. It may be transferred by casual contact, wiping, brushing, or washing.

**MicroRoentgen per hour (MicroR/hr)** - A unit of gamma exposure rate used when measuring gamma radiation exposure rate associated with NORM contaminated equipment with a scintillation instrument.

**MilliRem (mR)** - A unit of radiation dose.



**NORM Decontamination License** - A license issued by a state that has state specific rules on NORM that allows a company to conduct NORM decontamination work. NORM Decontamination licenses must be applied for and include onerous requirements. Also known as a Specific License.

**Non-Radiation Worker** - Worker or members of the public who are only allowed two percent of the annual occupational dose limit from industrial ionizing radiation

**Non-Routine Work** - A task where the risk of significant NORM exposure is high, and/or the creation of airborne NORM is unavoidable.

**NORM (Naturally Occurring Radioactive Material) also referred to as TENORM (Technologically Enhanced Naturally Occurring Radioactive Material)** - Consist of materials, usually industrial wastes or by-products enriched with radioactive elements found in the environment, such as uranium, thorium and potassium and any of their decay products, such as radium and radon. Natural radioactive elements are present in very low concentrations in earth's crust and are brought to the surface through human activities such as oil and gas exploration or mining, and through natural processes like leakage of radon gas to the atmosphere or through dissolution in ground water. Another example of TENORM is coal ash produced from coal burning in power plants. If radioactivity is much higher than background level, handling TENORM may cause problems in many industries and transportation

**Pancake Detector** - Detects ionizing radiation such as alpha particles, beta particles using the ionization effect produced in a Geiger-Müller tube; which gives its name to the instrument

**Person In Charge (PIC)** - For non-regulated NORM states, or when dealing with levels below thresholds requiring a RSO, or companies not conducting NORM decontamination activities; depending on state regulations someone who is knowledgeable and has experience with NORM may be placed to serve in a role like an RSO, without the certificates required to be a RSO. Note: in this document depending on what risk the company wishes to take for those specific situations a PIC can perform the roles that would normally be given to a RSO in a regulated State.

**Picocuries / gram (pCi/g)** - A unit of activity level of material determined by taking a material sample and sending it for analysis to a radiological laboratory.

**Pile** - A non-containerized accumulation of solid, non-flowing NORM waste.

**Radiation (RAD) Worker** - Individual likely to receive an occupational dose in excess of 1 mSv (100 mrem) in a calendar year.

**Radiation Exposure Rate** - A measurement in microR/hr determined by using a scintillation instrument, (e.g., Ludlum Model 2241 digital survey meter with a Ludlum 44-2 scintillation probe.)



**Radiation Safety Officer (RSO)** - The Radiation Safety Officer is responsible for recommending or approving corrective actions, identifying radiation safety problems, initiating action, and ensuring compliance with regulations

**Radiation Survey** - A measurement with a scintillation instrument to evaluate and assess the presence of radioactive materials or other sources of radiation.

**Radioactive Material** - Any material, whether solid, liquid, or gas, that emits radiation spontaneously

**Release Criterion** - A level of activity, exposure rate, or surface count rate, below which equipment/tubular, materials, or land areas can be released for unrestricted use.

**Routine Maintenance Work** - A task where the risk of significant NORM exposure is low, and/or the creation of airborne NORM is avoidable.

**Scintillation counter** - An instrument for detecting and measuring gamma ionizing radiation by using the excitation effect of incident radiation on a scintillator material, and detecting the resultant light pulses

**Shielding** - Barriers of lead, concrete, or water provide protection from penetrating radiation such as gamma rays and neutrons. This is why certain radioactive materials are stored under water or in concrete or lead-lined rooms, and why dentists place a lead blanket on patients receiving x-rays of their teeth. Similarly, special plastic shields stop beta particles, and air stops alpha particles. Therefore, inserting the proper shield between you and a radiation source will greatly reduce or eliminate the dose you receive

**Specific License** - A license issued by a state that has state specific rules on NORM that allows a company to conduct NORM decontamination work. Specific licenses must be applied for and include onerous requirements. Also known as a NORM Decontamination License.

**Survey** - In evaluation of the production, use, release, disposal, transfer, and/or presence of sources of radiation under a specific set of conditions to determine actual or potential radiation hazards. When appropriate, such evaluation includes, but is not limited to, tests, physical examination, and measurements of levels of radiation or concentrations of radioactive materials present.

**Total Effective Dose Equivalent (TEDE)** - A sum of the deep dose equivalent for external exposures plus the committed effective dose equivalent for internal exposures, generally expressed in units of millirem.

**Unrestricted Use** - A use that does not have controls in place to protect an individual member of the public from exposure

**NORM Work Plan** - A written plan to describing the equipment, PPE and procedure for working in and around a NORM contaminated equipment



### **3.0 ROLES AND RESPONSIBILITIES**

#### **3.1 Corporate NORM Radiation Safety Officer (RSO) or Person in Charge**

- 3.1.1 Maintains NORM procedures
- 3.1.2 Oversee Regional NORM Radiation Safety Officer (RSO)
- 3.1.3 Maintain NORM RSO Certification
- 3.1.4 Develop written NORM procedure and surveying/ sampling procedure
- 3.1.5 Review written NORM procedure content and implementation

#### **3.2 Regional NORM Radiation Safety Officer or Person in Charge**

- 3.2.1 Maintaining NORM RSO certification
- 3.2.2 Ensuring that the requirements of the general license as well as applicable State/Federal regulation are properly followed
- 3.2.3 Ensuring proper criteria are met before any NORM contaminated material or property is released for unrestricted use
- 3.2.4 Providing a list of specifically licensed contractors (or similarly qualified if not regulatory licensing is required) for the shipment, decontamination, treatment storage and/or disposal of NORM contaminated material or property to the management of the asset
- 3.2.5 Overseeing the storage, decontamination transfer to another facility and/or transfer for treatment/disposal of NORM contaminated material or property
- 3.2.6 Review Survey Report
- 3.2.7 Review NORM Work plan
- 3.2.8 Maintaining NORM related data (Survey data, Lab results, Shipping papers, etc.)
- 3.2.9 Assessing the effectiveness of the NORM Standard and the written NORM Program
- 3.2.10 If employees are performing NORM work under a specific License a Radiation Safety Officer (RSO) must be on-site to observe NORM work activities. If a contractor is performing NORM work under a specific license, their RSO must be present.

#### **3.3 NORM Surveyor**

- 3.3.1 Maintaining NORM Surveyor certification
- 3.3.2 Performing radiation and contamination surveys
- 3.3.3 Personal Air Monitoring
- 3.3.4 Documentation
- 3.3.5 Maintaining calibration of their equipment
- 3.3.6 Following NORM survey testing Procedures

#### **3.4 EHS Department**



- 3.4.1 Assisting operations in the implementation of the NORM Standard and the written NORM Procedure
- 3.4.2 Managing NORM awareness training requirements for employees
- 3.4.3 Ensuring that the NORM Work Plan and requirements for protection of employees, contractors, and the environment are followed.

### **3.5 Employees**

- 3.5.1 Understand the requirements of the NORM standard and the written NORM procedure and performing work in accordance with those requirements
- 3.5.2 Notify the RSO before conducting operations where NORM warning signs and labels are present
- 3.5.3 Make the Regional RSO aware of any problems encountered with NORM
- 3.5.4 Stop any NORM activity which may be dangerous to safety, health, equipment and/or environment
- 3.5.5 Follow the instruction of the NORM RSO

### **3.6 Contractors**

- 3.6.1 Observing NORM warning signs and labels
- 3.6.2 Notifying the point of contact before conducting operations where NORM warning signs/labels are present
- 3.6.3 Training their employees in the hazards and required PPE relating to NORM exposure
- 3.6.4 Reporting any NORM related incidents or issues in accordance with Incident reporting and investigation standard.
- 3.6.5 Providing NORM documentation and equipment for NORM work activities
- 3.6.6 Contractors performing NORM work activities in non-regulated state will still provide a radiation work plan and survey equipment during work. Regional RSO may assist Contractors Safety Professionals in designing plans.

### **3.7 Specifically Licensed Contractors (licensed by the state for radiation work)**

- 3.7.1 Conducting work in compliance with the applicable agency NORM regulation and following standard/procedure that are at least as stringent as standard and procedures
- 3.7.2 Reporting any NORM-related incidents or issues in accordance with incident reporting and investigation standard
- 3.7.3 Provide Radiation Work Permit, survey results, must furnish all survey equipment
- 3.7.4 Provide specific license and Company RSO credentials
- 3.7.5 Must place barriers while NORM work is being completed
- 3.7.6 Set-up Frisk-out station for NORM removal activities

### **3.8 Directors/Managers/Supervisor**



3.8.1 Implement the requirements of this standard

3.8.2 Required personnel assigned to perform work have the proper training and equipment for the job or task being performed

## **4.0 CONTROLS**

4.1 A combination of the following controls shall be used to reduce NORM exposure:

- Engineering Controls
- (ALARA) As Low As Reasonable Achievable
- Written NORM work plan
- Training
- Personal Protective Equipment (PPE)

4.1.1 Engineering Controls

Engineering Controls include any mean preventing human exposure through constructing equipment and systems to be closed there by preventing human exposure. (i.e. shielding from piping)

4.1.2 ALARA

Employees and third-party contractors shall reduce exposure to ALARA when working around NORM contaminated equipment and facilities by:

- Limiting the amount of time spent known NORM contaminated areas,
- Working at the maximum possible distance from NORM
- Using shielding to contain NORM material, including donning appropriate personal protective equipment
- Minimizing NORM environmental impacts by preventing contamination of the soil or other equipment
- Sealing out-of-service and/or stored NORM contaminated equipment in plastic or closing all fittings to prevent NORM dust or scale from collecting on soil
- Utilize secondary containment on open NORM contaminated equipment to contain any material which may be deposited on the ground

4.1.3 Written NORM Work Plan

- A Hazard Assessment shall determine the need for a written NORM work plan.
- The NORM work plan must be written and approved by a Radiation Safety Officer (RSO)
- The work plan shall be a separate document available to all employees (Contractor) or representatives of the state regulatory agency when requested or required by state regulations
- The work plan will apply to the work being performed.
- Any employee or third-party contractor must be trained on and must follow the work plan before performing work on equipment/tubular and facilities contaminated with NORM above the exemption limits.



*Note: Review current state regulation on NORM Decontamination for any additional license or requirement needed before conducting work (i.e. Texas requires five days notification and agency approval before NORM decontamination can be conducted)*

4.1.4 Training

A NORM Training program composed of three courses shall be implemented for employees.

Courses include:

- NORM Awareness - Required for any employee that have the potential to work with NORM
- NORM Surveyor - Required for any employee who will conduct equipment/tubular surveys for NORM contamination at a site/facility. This training may include surveying for loose surface contamination, surveying soils, NORM sampling, or shipping of NORM samples for laboratory analysis.
- NORM RSO - Required for any employee/ or third-party state licensed contractor who will be performing the duties of NORM Radiation Safety Officer.

4.1.5 Personnel Protective Equipment (PPE)

PPE requirements are based on tasks and contamination levels determined by the hazard assessment. If additional PPE is required, contact Regional RSO.

4.2 Radiation Thresholds

4.2.1 United States National Radiation Commission Federal Guidelines for Radiation Thresholds

Federal Regulation Effluent Concentrations (Air) Values

- Radium-226 is  $9 \times 10^{-13} \mu\text{Ci/ml}$
- Radium-228 is  $2 \times 10^{-12} \mu\text{Ci/ml}$
- Lead-210 is  $6 \times 10^{-13} \mu\text{Ci/ml}$
- Polonium-210 is  $9 \times 10^{-13} \mu\text{Ci/ml}$

Non- occupational annual dose limit

- General Public - 0.1 rem/year
- Pregnant Workers - 0.5 rem during the entire gestation period
- 50 microR/hr Threshold for some states to classify something as NORM contaminated

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*50 microR/hour is calculated as follows  
0.1 R = 0.1 Roentgen for this situation  
0.1R = 100,000 microR  
100,000 microR / 2,000 man hours = 50 microR*

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4.2.2 Current States with additional NORM Regulations include North Dakota, Texas, New Mexico, Minnesota, Ohio, Mississippi, Louisiana, West Virginia and Arkansas.



4.3 Signage – General

- Removal of NORM regulated Equipment by a licensed contractor.
- Allow equipment/filter elements to vent for an extended period (e.g., 1-2 hrs.) to allow dose rate levels to decrease to below the regulated TENORM limits.
- Note: will not reduce the levels of surface contamination

4.3.1 Equipment/Tubulars contaminated with NORM  $> 50 \mu\text{R}/\text{Hr}$   $< 2,000 \mu\text{R}/\text{Hr}$  shall be identified with a clearly visible sign marked with the letters “NORM” legibly written with a waterproof paint or ink. For an interconnected equipment system such as wellhead, flow line, or facility piping system, identify the system as a whole with a sign as described above. Check state regulations on bottom threshold number.

4.3.2 The radiation symbol is reserved for exposure readings that are higher than the NORM thresholds  $> 2000\mu\text{R}/\text{Hr}$ . When using the three- blade tri-foil, use magenta, purple, or black on a yellow background that can be taped on or painted on. It must follow the protection plan from the Decontamination Company or areas where a member of the public could receive a total effective dose (TEDE greater than 0.1 rem/year) exclusive of background and medically administered radiation or radioisotopes.

4.3.3 Group of equipment/tubulars, some of which are NORM contaminated, that are kept in a common container, stack, or are wrapped, bound or tied securely together should be tagged or marked “NORM”. Any piece of equipment in the group may be NORM-contaminated.

4.4 NORM survey, sample, and/or personnel monitoring results should be reviewed by the RSO for determination of appropriate actions, if any.

4.4.1 Recommended contents of NORM survey forms:

- Surveyor’s Name
- Date of Survey
- Reason Survey (confirmatory, maintenance, release)
- Survey Meter (model, serial #, calibration date, battery status)
- Check Source Information (S/N, calibration date, pre- and post- readings)
- Background Reading
- Location (address, GPS coordinates, description)
- Sketch of the Survey Area and/or Photos
- Description of Item(s) Surveyed
- Results ( $\mu\text{R}/\text{hr}$  and CPM)
- Comments
- Signature of Surveyor and Date (each page)
- Company RSO signature and date (reviewed by)

4.4.2 Results of equipment internal surveys should be disclosed as part of the change of ownership (e.g., sale) and/or disposal of equipment or materials. Use of a Transfer of Custody FORM along with decontamination information should be disclosed.



- 4.4.3 NORM survey, sample, and personnel monitoring results should be maintained per the company retention policy and recordkeeping procedures.
- 4.4.4 After survey and lab results are reviewed by IH/RSO provide survey data to employees in the work area.
- 4.4.5 To support the defensibility of NORM survey results, survey instrument calibration records (e.g., annual calibrations, check source results) and maintenance records should be maintained per the company retention policy and recordkeeping procedures.
- 4.5 NORM Sampling for transport, disposal, or equipment sale
- 4.5.1 NORM sampling shall be conducted before transporting, disposing, or sale of NORM contaminated waste, material, or equipment.
- Waste characterization testing cannot be done on site and samples must be sent out to an approved laboratory for analysis.
- 4.5.2 Most waste from gas transmission lines and equipment not inside of a processing facility can be disposed of at a facility permitted to handle non-hazardous oil and gas waste containing NORM as long as the non-hazardous nature of the waste has been verified. To comply with federal Resource Conservation and Recovery Act (RCRA) waste standards, this requires:
- Full Toxicity Characteristic Leachate Procedure (TCLP) testing; and
  - Reactive, Corrosive, and Ignitable (RCI) testing.
- 4.5.3 Contracting the appropriate laboratory that can analyze NORM, use the appropriate chain-of-custody, sample packing, shipping requirements, turn-around time, and results reporting. Coordinate closely with the laboratory and disposal facility:
- The list of analytical requirements for NORM disposal can vary based on the disposal facility's requirements. Confirm the specific isotopes required by the waste disposal facility.
  - Include analyses to meet RCRA requirements if necessary (e.g., flashpoint, leachable metals, etc.).
  - In addition, instruct the laboratory to report the radiation results using Picocuries and Becquerel (per liter) to support proper DOT classification.
- 4.6 Decontamination and Cleaning
- 4.6.1 Decontamination of NORM contaminated equipment must use a Specifically Licensed Company in states with NORM-specific regulation or knowledgeable NORM personnel / contractors in other states.
- 4.6.2 A decontamination program should be supervised by a knowledgeable NORM personnel or in some states with NORM specific regulations require a NORM RSO:
- Substantial training for personnel.
  - Site-specific health and safety program.
  - Personnel monitoring using radiation badges or detectors.



- 4.6.3 The use of spill trays or containment trays, or sheeting materials to prevent overspray causing the spread of NORM contamination.
- 4.6.4 A Spill Control Plan and spill kits are recommended.
- 4.6.5 NORM impacted equipment that are not wastes, for example smart pigs, and may need decontamination onsite due to state rules and Compacts. This work should be conducted within a restricted area within which workers use appropriate PPE and all waste is collected for appropriate disposal.

*NOTE: test smart pig for NORM prior to inserting into equipment and systems to prevent cross contamination.*

- 4.6.6 Non-disposable (Level C with respirators) PPE and equipment (including pigs) used during NORM clean-up and/or decontamination activities should be cleaned and surveyed with the “pancake” probe prior to being removed from the designated NORM work area. Decontaminate any contamination above twice background CPM levels (using a Specific Licensed contractor if necessary) or dispose of the materials as NORM waste.
- 4.6.7 Personnel should remove any potentially NORM-containing materials and thoroughly wash after working with potentially NORM-containing equipment.

*Note: Baby wipes work well for removing NORM from skin*

4.7 Area-cleanup

- 4.7.1 If any NORM-contaminated sludge or scale was released on to the ground-cover in the area, it must be collected by personnel wearing suitable level C PPE and be containerized for storage and appropriate disposal.
- 4.7.2 Using an appropriate survey meter with the scintillation probe connected, survey the land area where NORM operations or the spill occurred. Where required, remove NORM to twice the local background dose rate.
- 4.7.3 If there are any readings above background, further cleanup may be necessary. Inform your RSO or PIC for further instructions.

4.8 NORM Storage & Waste Management

*Note: States with NORM-specific regulations often have specified time limits and associated financial surety for the storage of NON-exempt NORM wastes. It is recommended that NORM wastes are NOT stored for longer than 1 year.*

- 4.8.1 Store all NORM-contaminated material in containers suitable for transportation (e.g., DOT-approved container, will not leak or spill during transportation). Confirm that:
  - Waste is stored in a secure, temporary storage area.
  - The container is compatible with the waste material
  - Stored so that the ability of the container to contain the waste is not impaired or compromised.



- Closed and sealed during storage, except when it is necessary to add or remove waste.
- Not be opened, handled, or stored in a manner that may rupture the container or cause it to leak.

4.8.2 Maintaining a NORM Storage Area Log is a recommended practice.

4.8.3 Mark each container and piece of equipment stored in the NORM storage area with a unique identification number.

Keep records of the following information in the log:

- Where material came from
- Date of transfer to NORM compound
- Identification number.
- Location of the material in the storage area. A plot plan can be used.
- Type of radioactive material in the container (i.e., Pigging waste, PPE, etc.).
- Date that the material entered and/or was removed from the storage area.
- Radioactivity level of the material in  $\mu\text{R}/\text{h}$  or  $\text{pCi}/\text{g}$ .
- Person responsible for the waste

4.8.4 Inspect NORM storage areas at least quarterly and keep an up-to-date inspection log.

#### 4.9 Disposal

4.9.1 NORM waste must be managed and disposed of in accordance with state and federal requirements by transfer to a disposal facility licensed by any one of:

- US Nuclear Regulatory Commission
- State regulatory department
- An Agreement State
- A licensing state, or
- By other methods approved by the state regulatory department.

4.9.2 Waste material (solid, liquids, soil contaminated PPE, etc.) should be characterized. If found to have concentrations greater than the state-specific or other requirements or thresholds, the item or material must be classified as NORM waste.

4.9.3 Select an appropriately permitted disposal facility and initiate the waste characterization and profiling process.

4.9.4 Correctly characterize and classify the waste.



- 4.9.4.1 If the suspected NORM waste is also Hazardous Waste as defined under RCRA, handle the waste per NORM storage requirements and in accordance with the applicable hazardous waste procedures.
- 4.9.4.2 Confirm the specific isotopes (and RCRA parameters if necessary) are at concentrations acceptable to the waste disposal facility.
- 4.9.4.3 Review the radioactivity of the waste and the load Picocuries and Becquerel (per liter or per gram) to support proper DOT classification.
- 4.9.4.4 Check waste profile and acceptance requirements well in advance of disposing of the waste. Waste disposal facilities often have strict requirements for creating waste profiles and need to know details such as:
  - Physical and chemical description of waste.
  - The Specific Activity of each radionuclide in pCi/g from the laboratory results.
  - Packaging
- 4.9.4.5 After completing the waste profiling process, dispose of all NORM wastes at the approved/ permitted facility.
- 4.9.4.6 Note: There may be additional State and Compact rules that must be followed.

**4.10 NORM Transportation**

- 4.10.1 Sample analytical results are usually required to correctly classify the material or equipment to be shipped since the types of radioisotopes and the Specific Activity of each must be known.
- 4.10.2 49 CFR Parts 171 and 180 – DOT Definition of Radioactive Materials
  - Radioactive material means any material containing radio nuclides where both the activity and the total activity in the consignment exceed the values specified in the table in § 173.436 or values derived according to the instructions in § 173.433.
  - However, this is modified Part 49 CFR 173.401(b)(4) which provides an exemption for Natural material and ores containing naturally occurring radionuclides which are not intended to be processed for use of these radionuclides, provided the activity concentration of the material does not exceed 10 times the values specified in § 173.436.

**TABLE 9—NON-FIXED EXTERNAL RADIOACTIVE CONTAMINATION LIMITS FOR PACKAGES**

Contaminant	Maximum permissible limits		
	Bq/cm <sup>2</sup>	uCi/cm <sup>2</sup>	dpm/cm <sup>2</sup>
1. Beta and gamma emitters and low toxicity alpha emitters	4	10 <sup>-4</sup>	220
2. All other alpha emitting radionuclides .....	0.4	10 <sup>-5</sup>	22



**Table 4.10-1: Exempt values for Ra-226 Ra-228 and Pb-210 (and progeny) per 49 CFR 173.436 modified per DOT 49 CFR 173.401 by multiplying values specified in 49 CFR 173.436 by 10**

Isotope of Radionuclide	Activity concentration for exempt material	Activity (Ci) per unit mass (g)	Activity limit for exempt consignment (i.e., whole load on transport) (Bq)	Activity per unit mass (Ci) multiplied by total mass of shipment
Ra-226	100 Bq/g	$2.7 \times 10^{-9}$ Ci/g	10,000 Bq	$2.7 \times 10^{-6}$ Ci
Ra-228	100 Bq/g	$2.7 \times 10^{-9}$ Ci/g	100,000 Bq	$2.7 \times 10^{-5}$ Ci
Pb-210	100 Bq/g	$2.7 \times 10^{-9}$ Ci/g	10,000 Bq	$2.7 \times 10^{-6}$ Ci

4.10.3 Ra226 and its progeny (Po218, Pb214, Bi214, Po214, Pb210, Bi210 and Po210) are included in this specific activity and, as such, most NORM shipments are considered non-radioactive by DOT.

4.10.4 Most NORM shipments over 2700 pCi/g will require the LS-I label unless exceedingly high concentrations of gamma producing Ra226 or Ra 228 are present. If high levels of Ra226 are present, an LS-II yellow label may be necessary:

One of three labels may be required depending on the external surface readings of the containers and the Transportation Index (TI). The external surface reading is the highest reading read 0.5 cm away from the packing container surface, measured from all around the container surfaces. The TI is the highest reading taken 1 m from the load. Unfortunately, the readings are dose rate equivalent measured in mSv/hr or mrem/hr.

*Note: 1 mrem/h is approximately equivalent to 1 mR/h or 1000μR/h*



Table 4.10-2: Transportation of Hazardous Materials Labels for non-exempt shipments.

Shipping label*	Surface reading (mrem/h)	TI
LS-I (white) 	≤ 0.5	Not required
LS-II (yellow) 	≤ 50	0-1
LS-III (yellow) 	> 50	> 1

\* Note: other labels may be necessary if the material has other hazardous properties, such as flammability, toxicity, etc.

4.10.5 Shipper needs to be DOT-certified for shipping hazardous materials. Confirm certification and any applicable permits needed to haul the waste are valid.

4.10.6 Strong Recommendation: **Do Not Ship NORM materials or potentially-NORM samples by Air.** If air shipment is necessary, follow IATA requirements (e.g., maximum allowable radiation level of 500 µR/hr measured on the external surface of the package, approved containers, “candy-striped” labels, identification number “UN 2910”, use authorized shippers only, observe quantity limits).

4.10.7 A signed copy of the bill-of-lading (DOT shipping papers) is required when transporting material that contains NORM. This documentation must state the material is “oil and gas wastes, contains naturally occurring radioactive materials (NORM)”.

4.10.8 Using a manifest system for the transport and disposal of NORM wastes is required by certain states.

4.10.9 Confirm that the carrier understands the nature of the load and provide the carrier with the name and phone number of a company contact. Also, verify that the carrier is qualified and has the appropriate permits needed to haul the waste.

Shipper needs approval from the receiver prior to dispatch of each shipment to ensure it will be accepted and secured on arrival at the disposal facility.

4.11 Documentation and Recordkeeping

Records should be maintained per company procedures and retention policies.

4.11.1 Facilities that transport NORM-contaminated waste offsite for disposal should maintain a record for each shipment. These records should include:

- Name of the facility generating the material.



- Physical nature of the material disposed of (i.e., sludge, scale, contaminated soil, etc.).
- Radioactivity level of the material in cpm,  $\mu\text{R/h}$  ( $\mu\text{Sv/h}$  if available) and pCi/g.
- Name and address of the transporter.
- Name and address of the treatment or disposal facility to which the material is shipped.
- Date the material was generated and the date the material was shipped.
- Volume of material shipped.
- Documentation associated with the shipment (i.e., bill-of-lading or manifest).

4.12 State Radiation and NORM Requirements

4.12.1 See Appendix A for some state-specific requirements.

4.12.2 Refer to the state agency-specific regulations for details on their requirements.

*Note: Changes in State and/or Federal regulations that include more strict limits automatically supersede the state-specific requirements in Appendix A.*

5.0 POTENTIAL PROCEDURES

5.1 Hazard Assessment

5.1.1 A hazard assessment will be performed to identify potential NORM related health, safety and/or environmental hazards associated with work activities where NORM exposure may occur. Hazard assessments are completed by performing a NORM Survey. Surveys include: area monitoring, air monitoring, and/or sample analysis.

5.2 NORM Survey Procedure

5.2.1 Equipment needed for area and direct survey:

1	Amplifier	<ul style="list-style-type: none"> <li>• Analog (Recommend: Ludlum 3)</li> <li>• Digital (Recommend: Ludlum 4)</li> </ul> <p><i>Note: For Non-intrinsically safe equipment. Surveyor must have LEL gas detector and Hot Work Permit when required.</i></p>
2	Probe/Detector	<ul style="list-style-type: none"> <li>• Scintillation Probe (AKA: HotDog Probe)(Recommend Ludlum 44-2)</li> <li>• Reads Gamma radiation</li> <li>• Reads in microR/Hr</li> <li>• Set on Fast Speed</li> <li>• Four (4) second response from Probe to Amplifier</li> <li>• Pancake Probe (AKA: G-M Probe; Geiger-Müller) (Recommend Ludlum 44-9)</li> <li>• Reads Alpha and Beta</li> <li>• Reads in Counts Per Minute (CPM)</li> </ul>



		<ul style="list-style-type: none"> <li>• Set on Slow Speed</li> <li>• (22) second response from Probe to Amplifier</li> </ul> <p><i>Note: Both Probes/Detectors are fragile and must be handled with care. Detectors and Amplifier are calibrated together and should not be used with any other set. The size of the GM window is incorporated into the math for the conversion from Counts per Minute (CPM) to DPM Disintegrations per minute DPM.</i></p>
3	Cable	<ul style="list-style-type: none"> <li>• Cable should be purchased through manufacture of survey equipment.</li> <li>• Distance of cable is incorporated into the math of signal from probe to Amplifier readings.</li> <li>• The cable should be rolled in its natural role and laid up on the instrument when putting it back in the case. Wrapping it around instrument or handle will break wires and destroy the cable.</li> <li>• Spare batteries and cable are recommended to be in your meter carrying case</li> </ul>
4	Check Source	<ul style="list-style-type: none"> <li>• Sampling with a meter - Check/Response Source</li> <li>• This is a low activity concentration source (example: approximately 0.25 microCi that is contained on a small round disk.) It is designed to check whether the instrument is within the calibration limits of plus or minus twenty (+/- 20%) of what it was when it was sent it to the laboratory to be calibrated. At the laboratory the instrument is tested against a known source to ensure it is calibrated. Then it is tested against the check source. The reading on the calibration sticker on the side of the instrument is the calibration to the check source readings. One way to store the check source is to have Ludlum adhere it to the side of the instrument in a box. The check source can be used with multiple instruments, but if the instrument uses that check source to be calibrated, then it must continue to use that source until it is recalibrated in the laboratory to another source.</li> </ul>
5	Sheet of Paper	<ul style="list-style-type: none"> <li>• This paper will be placed in front of the open end of a Geiger-Müller probe to get the reading of Beta particles</li> <li>• Type of paper (Notebook, copy paper, stick note)</li> </ul>



6	Wet wipes	<ul style="list-style-type: none"> <li>This will be used to wipe loose contamination from piping or equipment for surveying</li> </ul>
7	Radiation Survey Grid	
8	Fixed Surface Contamination Survey Form	
9	Removable surface contamination Survey Form	

**5.3 Gamma Survey of Scrap Metal/Equipment Procedure**

- Sampling should take place while vessels and pipelines are inactive as flow causes fluctuating results
- Begin the survey with an Equipment check of the Ludlum meter with scintillation probe (Ensure the meter is set to the fast speed during testing.)
- Complete header section of a Radiation Survey Grid
- Draw the scrap metal and/or equipment that will be surveyed on the Radiation Survey Grid.
- Place the scintillation probe 1cm or less from the equipment and move laterally down the metal/equipment at a speed less than six (6) inches per second. Record meter readings at several locations on the radiation grid drawing.
- When the scrap metal and/or equipment survey is complete, perform post bump check with check source and document results on a Radiation Survey Grid Form.
- Review reading and ensure the gamma exposure exemption limits have not been exceeded.
- Send copy of completed Radiation Survey Grid to Regional RSO

**5.4 Alpha/Beta of Scrap Metal/ Equipment Survey Procedure**

Surveying can only take place when scrap metal/equipment is open to atmosphere at the equipment opening.

- Begin the survey with an equipment check of the Ludlum meter (Ensure the meter is set to the slow speed during testing)
- Complete header section of a Radiation Survey Grid
- Draw the scrap metal/equipment opening that will be surveyed on the Radiation Survey Grid
- Place the Geiger-Mueller probe 1cm or less from the equipment opening and travel around the edge of the opening at a speed less than 1 inches per second. Record meter reading at several locations on the Radiation Survey grid drawing (These readings are Alpha and Beta Particles)
- Place and hold a sheet of paper in front of the Geiger-Mueller probe window.



- Re-survey the equipment opening place the Geiger-Mueller probe 1cm or less from the equipment opening and travel around the edge of the opening at a speed less than 1 inches per second. Record meter reading at several locations on the grid drawing (These readings are Beta Particles)
- Perform post-bump check with check source and document results on Radiation Survey Grid Form.
- Send copy of completed Radiation Survey Grid to Regional RSO

#### 5.5 Fixed Surface Contamination Survey Procedure

- Begin the survey with an equipment check of the Ludlum meter using a Geiger-Mueller probe.
- Complete the first portion of the Fixed Surface Contamination Survey Form
- Draw the scrap metal/equipment opening that will be surveyed on the Fixed Surface Contamination Survey Procedure.
- Place the Geiger-Mueller probe 1cm or less from the equipment opening or where scale is exposed and travel around the edge of the opening at a speed less than 1 inch per second. Record meter readings at several locations on the Radiation Survey grid drawing (These readings are Alpha and Beta Particles)

**Note:** For piping/equipment with scale inside, if the pipe/equipment is large enough, place the probe inside the pipe near the opening to get an average CPM. It is not necessary to scan the entire inside the pipe with scale.

- Place and hold a sheet of paper in front the Geiger-Mueller probe window
- Re-survey the equipment opening or exposed scale by placing the Geiger-Mueller probe 1cm or less from the equipment opening and travel around the edge of the opening at a speed less than 1 inch per second. Record meter readings at several locations on the grid drawing (These reading are Beta Particles)
- The surveyor will calculate the  $DPM/100cm^2$  for the fixed contamination form.

**Note:** To go from CPM to DPM consult owner's manual of survey meter. Conversion depends on the size of the Geiger-Muller probe window

- On the fixed contamination form provide an average of the CPM and the highest CPM reading

#### 5.6 Removable Surface Contamination Survey Procedure

- Begin the survey with an equipment check of the Ludlum meter using a Geiger-Mueller probe.
- Complete the first portion of the Removable Surface Contamination Form
- After completing the system check, take a wet wipe and using moderate pressure swipe or smear a  $100cm^2$  area. (This can be completed by swiping a 4-inch x 4-inch area or 1-inch by 16-inch S shape swipe area. If the removable surface is larger than  $100cm^2$  take a sample from an area that is most appropriate to show a representative assessment)
- Once the swipe is complete, remove wet wipe from equipment and place on flat surface



- **(Note:** Ensure surface is not contaminated before placing wet wipe down)
- Use the Ludlum and Geiger-Mueller probe to survey the wet wipe placing the Geiger-Mueller probe 1cm or less from the wet wipe at a speed less than 1 inch per second. Record meter reading on the Removable Surface Contamination Form
- Place and hold a sheet of paper in front the Geiger-Mueller probe window
- Re-survey the wipe with the paper sheet in front of the probe opening. Record your CPM. (Beta particle)
- The surveyor will calculate the DPM/100cm<sup>2</sup> for the removable surface contamination form.

**Note:** To go from CPM to DPM consult owner’s manual of survey meter. Conversion depends on the size of the Geiger-Mueller probe window

**Note:** For the States with NORM Surface Contamination Exemption Limits review the results and ensure values are not exceeded per state regulations, if any results exceed limits; perform NORM Decontamination and repeat the survey above to confirm results are under thresholds

5.7 Product or Waste Sample Procedure

5.7.1 Equipment Needed:

- Zip lock bag
- 1 gallon Plastic container with secure seal lid

5.7.2 Filter Samples

- Using a box blade cut a 4” by 4” sample. The sample shall be cut all the way through the filter material
- Place the sample in a sealed container or sealed zip lock bag
- Once all the samples are collected, place them in a secondary container for transport to the lab. Ensure the samples are secured in the secondary container with proper chain of custody documents for the lab. Perform a survey of the sealed secondary container with the meter and scintillation probe. If the readings are below 50µR/hr then the shipment is ready. If the readings are over 50µR/hr contact regional RSO for instructions. All shipments should be sent ground only.

5.7.3 Liquid Samples

- For liquid waste, use a plastic container that can be sealed to collect your sample. Have on appropriate PPE to collect your liquid sample. Have secondary containment to prevent any unattended spill to the ground. Collect 1 gallon of liquid waste.
- Once all the samples are collected, place them in a secondary container for transport to the lab. Ensure the samples are secured in the secondary container with proper chain of custody documents for the lab. Perform a survey of the sealed secondary container with the meter and scintillation probe. If the readings are below 50µR/hr then the shipment is ready. If the readings are over 50µR/hr contact regional RSO for instructions. All shipments should be sent ground only.



#### 5.7.4 Solid Samples

- For solid waste, use a plastic container that can be sealed to collect your sample. Have on appropriate PPE to collect your solid sample. Have secondary containment to prevent any unattended spill to the ground. Collect 1 quart or ½ lb of solid waste. Ensure solid waste cannot become airborne while collecting sample. If solid waste will become airborne contact regional RSO for instructions.

5.7.5 Once all the samples are collected, place them in a secondary container for transport to the lab. Ensure the samples are secured in the secondary container with proper chain of custody documents for the lab. Perform a survey of the sealed secondary container with the meter and scintillation probe. If the readings are below 50µR/hr then the shipment is ready. If the readings are over 50µR/hr contact regional RSO for instructions. All shipments should be sent ground only.

## 6.0 REFERENCES

Current versions of the references automatically supersede the references listed below.

### 6.1 Occupational Safety and Health Administration (OSHA)

6.1.1 Title 29 CFR §910.1096, Ionizing Radiation

### 6.2 Department of Transportation (DOT)

6.2.1 Title 49 CFR §173, Shippers, General Requirements for Shipments and Packaging, Subpart I - Class 7 (Radioactive) Materials

6.2.2 Title 49 CFR §173.401 – §173.476 – US Department of Transportation (DOT), Class 7 (Radioactive) Materials

### 6.3 Canadian NORM Working Group

6.3.1 Canadian Guidelines for the Management of Naturally Occurring Radioactive Material (NORM), Health Canada, Canadian NORM Working Group, Federal Provincial Territorial Radiation Protection Committee, first edition, October 2000, updated 2011.

### 6.4 International Atomic Energy Agency (IAEA)

6.4.1 IAEA, Radiation Protection and the Management of Radioactive Waste in the Oil and Gas Industry, Safety Series No 34 (2003).

6.4.2 IAEA, Regulatory and Management Approach for the Control of Environmental Residues Containing Naturally Occurring Radioactive Material (NORM), IAEA-TECDOC-1484 (2004).

6.4.3 IAEA, Naturally Occurring Radioactive Materials (NORM IV), IAEA-TECDOC-1472 (2005).

6.4.4 IAEA, Extent of Environmental Contamination by Naturally Occurring Radioactive Material (NORM) and Technological Options for Mitigation, Technical Reports Series No 419 (2003).

6.4.5 IAEA, Regulations for the Safe Transport of Radioactive Material, 2005 Edition No TS-R-1.

### 6.5 State-Specific (Refer to Appendix A page 43 et al.)



- Kentucky

6.5.1 Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) Associated with Oil and Gas Activities. – Report to the Kentucky Legislative Research Commission Pursuant to 2016RS HB 563, Prepared by the Kentucky Energy and Environmental Cabinet and Kentucky Cabinet for Health and Family Services, November 30, 2016

- Louisiana

6.5.2 33 LAC Part XV, §1401 – 1499, Louisiana Department of Environmental Quality, Regulation and Licensing of Naturally Occurring Radioactive Material

6.5.3 Louisiana Department of Environmental Quality Radiation Protection Division, Implementation Manual for Management of NORM in Louisiana, Draft, September 1995

- Mississippi

6.5.4 Mississippi State Oil & Gas Board Statewide Rules and Regulations, Rule 69

- Oregon

6.5.5 Oregon Administrative Rules, Chapter 333, Division 117, "Regulations and Licensing of Naturally Occurring Radioactive Materials."

- Texas

6.5.6 25 TAC §289.259 (TRCR Part 46) – Texas Department of State Health Services, Licensing of Naturally Occurring Radioactive Material, Texas Regulations for Control of Radiation

6.5.7 16 TAC §4.601 – 4.632, Railroad Commission of Texas, Oil and Gas NORM

**6.6 Other**

6.6.1 API Bulletin E2, Bulletin on Management of Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Production; Second Edition, April 2006

6.6.2 ENFORM, NORM Safety Training, 2nd Edition February 2008

6.6.3 Guidelines for the Management of Naturally Occurring Radioactive Material (NORM) in the Oil & Gas Industry, International Association of Oil & Gas Producers, September 2008

**7.0 HISTORY OF REVISIONS**

Number	Date	Description
0	May 2018	Initial publication of this INGAA Construction Safety Consensus Guidelines document.



## Appendix A

### State Radiation and NORM Requirements

Refer to the state agency-specific regulations for details on their requirements.

*Note: Changes in State and/or Federal regulations that incorporate more strict limits automatically supersede the state-specific requirements in Appendix A.*

Table A-1. State-specific Requirements

State / State Agency	Extent of Regulations	Website
<b>Arkansas</b>		
Department of Health	Possession, Decontamination, and Worker Protection	<a href="http://www.healthy.arkansas.gov/programsServices/hsLicensingRegulation/RadiationControl/Pages/RulesandRegulations.aspx">http://www.healthy.arkansas.gov/programsServices/hsLicensingRegulation/RadiationControl/Pages/RulesandRegulations.aspx</a>
<b>California</b>		
California Department of Conservation  Division of Oil, Gas, and Geothermal Resources	Oil and Gas Agency	<a href="http://www.conservation.ca.gov/dog">http://www.conservation.ca.gov/dog</a>
Department of Public Health - Radiological Health Branch	Radiation Control Agency	<a href="http://www.cdph.ca.gov/programs/Pages/RadiologicHealthBranch.aspx">http://www.cdph.ca.gov/programs/Pages/RadiologicHealthBranch.aspx</a>
General Radiation Control Regulations	California Code of Regulations, Title 17, Division 1, Chapter 5, Subchapter 4, "Radiation".	<a href="http://www.cdph.ca.gov/programs/Pages/RHB-Regulations.aspx">http://www.cdph.ca.gov/programs/Pages/RHB-Regulations.aspx</a>
<b>Illinois</b>		
Department of Natural Resources, Office of Mines and Minerals, Division of Oil and Gas	Oil and Gas Agency	<a href="https://www.dnr.illinois.gov/mines/Pages/default.aspx">https://www.dnr.illinois.gov/mines/Pages/default.aspx</a>



State / State Agency	Extent of Regulations	Website
Illinois Emergency Management Agency, Department of Nuclear Safety, Division of Radioactive Materials	Radiation Control Agency	<a href="https://www.illinois.gov/iema/laws/Pages/Statures-GeneralRadiation.aspx">https://www.illinois.gov/iema/laws/Pages/Statures-GeneralRadiation.aspx</a>
Illinois Administrative Code	<i>Illinois Administrative Code</i> , Title 32, Chapter II, Subchapter b, "Radiation Protection".  <i>Illinois Administrative Code</i> , Title 62, Chapter I, Section 240, "Illinois Oil and Gas Act".	<a href="https://www.illinois.gov/iema/laws/Documents/Regs/32_340.pdf">https://www.illinois.gov/iema/laws/Documents/Regs/32_340.pdf</a>  <a href="ftp://www.ilga.gov/JCAR/AdminCode/062/06200240sections.html">ftp://www.ilga.gov/JCAR/AdminCode/062/06200240sections.html</a>
<b>Indiana</b>		
Department of Natural Resources, Division of Oil and Gas	Oil and Gas Agency	<a href="http://www.in.gov/dnr/dnroil/">http://www.in.gov/dnr/dnroil/</a>
State Department of Health, Indoor and Radiologic Health Program	Radiation Control Agency	<a href="http://www.in.gov/isdh/24351.htm">http://www.in.gov/isdh/24351.htm</a>
Indiana Administrative Code	<i>Indiana Administrative Code</i> , Title 410, Chapter 5: "Radiological Health"	<a href="http://www.in.gov/legislative/iac/iac_title?iac_title=410">http://www.in.gov/legislative/iac/iac_title?iac_title=410</a>
<b>Iowa</b>		
Department of Health, Bureau of Radiological Health	Radiation Control Agency	<a href="http://idph.iowa.gov/radiological-health">http://idph.iowa.gov/radiological-health</a>
Iowa Administrative Code	<i>Iowa Administrative Code</i> , Title 641, Chapters 38 – 45	<a href="https://www.legis.iowa.gov/law/administrativeRules/chapters?pubDate=04-07-2010&amp;agency=641">https://www.legis.iowa.gov/law/administrativeRules/chapters?pubDate=04-07-2010&amp;agency=641</a>
<b>Kansas</b>		



State / State Agency	Extent of Regulations	Website
Kansas Corporation Commission, Oil & Gas Conservation Division	Oil and Gas Agency	<a href="http://www.kcc.state.ks.us/conservation/index.htm">http://www.kcc.state.ks.us/conservation/index.htm</a>
Kansas Department of Health & Environment, Bureau of Air and Radiation, Radiation and Asbestos Control	Radiation Control Program	<a href="http://www.kdheks.gov/radiation/">http://www.kdheks.gov/radiation/</a>  <a href="http://www.kdheks.gov/radiation/norm.htm">http://www.kdheks.gov/radiation/norm.htm</a>
Kansas Radiation Control Regulations and Statues	<i>Kansas Administrative Regulations, Agency 28, Article 35, "Radiation".</i>	<a href="http://www.kdheks.gov/radiation/regs.html">http://www.kdheks.gov/radiation/regs.html</a>
<b>Kentucky</b>		
Energy and Environment Cabinet, Department of Natural Resources, Division of Oil and Gas Conservation	Oil and Gas Agency	<a href="http://oilandgas.ky.gov/Pages/Welcome.aspx">http://oilandgas.ky.gov/Pages/Welcome.aspx</a>
Cabinet for Health and Family Services, Department for Public Health, Radiation Health Branch	Radiation Control Agency	<a href="http://chfs.ky.gov/dph/radiation.htm">http://chfs.ky.gov/dph/radiation.htm</a>
Kentucky Regulations and Statues	<i>Kentucky Administrative Code, Title 401 Chapter 5:090. "Control of Water Pollution from Oil and Gas Facilities."</i>  <i>Kentucky Administrative Code, Title 401 Chapter 10:031. "Surface Water Standards."</i>  <i>Kentucky Administrative Regulations, Title 902, Chapter 100, "Radiology".</i>	<a href="http://www.lrc.state.ky.us/kar/TITLE401.HTM">http://www.lrc.state.ky.us/kar/TITLE401.HTM</a>



State / State Agency	Extent of Regulations	Website
		<a href="http://www.lrc.state.ky.us/kar/TITLE902.HTM">http://www.lrc.state.ky.us/kar/TITLE902.HTM</a>
<b>Louisiana</b>		
Department of Environmental Quality	Possession, Decontamination, and Worker Protection	<a href="http://www.deq.louisiana.gov/portal/tabid/1674/Default.aspx">http://www.deq.louisiana.gov/portal/tabid/1674/Default.aspx</a>  <a href="http://www.deq.louisiana.gov/portal/tabid/2283/Default.aspx">http://www.deq.louisiana.gov/portal/tabid/2283/Default.aspx</a>
Department of Natural Resources	Oil & Gas Exploration & Production Waste Storage, Treatment, and Disposal	<a href="http://www.dnr.louisiana.gov/index.cfm?md=pagebuilder&amp;tmp=home&amp;pid=135&amp;pnid=27&amp;nid=86">http://www.dnr.louisiana.gov/index.cfm?md=pagebuilder&amp;tmp=home&amp;pid=135&amp;pnid=27&amp;nid=86</a>
Louisiana Administrative Code	<i>Louisiana Administrative Code</i> , Title 33, Part XV, Chapter 14, "Regulation and Licensing of Naturally Occurring Radioactive Material (NORM)".  <i>Louisiana Administrative Code</i> , Title 33, Part XV, "Radiation Protection".	<a href="http://www.deq.louisiana.gov/portal/tabid/1674/Default.aspx">http://www.deq.louisiana.gov/portal/tabid/1674/Default.aspx</a>
<b>Michigan</b>		
Department of Environmental Quality, Office of Geological Survey, Oil and Gas	Oil and Gas Agency	<a href="http://www.michigan.gov/deq/0,4561,7-135-3311_4231---,00.html">http://www.michigan.gov/deq/0,4561,7-135-3311_4231---,00.html</a>
Department of Environmental Quality, Waste and Hazardous Materials, Radiological Protection	Radiation Control Agency	<a href="http://www.michigan.gov/deq/0,1607,7-135-3312_4120---,00.html">http://www.michigan.gov/deq/0,1607,7-135-3312_4120---,00.html</a>
Michigan Administrative Code	<i>Michigan Administrative Code</i> , R325.5001 - R325.5049, "Ionizing Radiation".	<a href="http://www.michigan.gov/deq/0,1607,7-135-3312_4120_4244-10069--,00.html">http://www.michigan.gov/deq/0,1607,7-135-3312_4120_4244-10069--,00.html</a>



State / State Agency	Extent of Regulations	Website
NORM-Specific Regulations	<p>"<i>Cleanup and Disposal Guidelines for Sites Contaminated with Radium-226.</i>"</p> <p>Special Order of the Supervisor of Wells and Supervisor of Mineral Wells, Order No. 3-6-92 and (M) 1-6-92, "<i>The Need and Desirability to Issue an Order Establishing Particular Requirements for Plugging Wells where Naturally-Occurring Radioactive Materials (NORM) May be Present</i>" (issued 11/3/92).</p>	<p><a href="http://www.michigan.gov/documents/deq/wm-rps-EQC-1602-200703-cleanup-disposal-guidelines-radium-226_192499_7.pdf">http://www.michigan.gov/documents/deq/wm-rps-EQC-1602-200703-cleanup-disposal-guidelines-radium-226_192499_7.pdf</a></p> <p><a href="http://www.michigan.gov/documents/deq/ogs-oilandgas-sow-3-6-92_261340_7.pdf">http://www.michigan.gov/documents/deq/ogs-oilandgas-sow-3-6-92_261340_7.pdf</a></p>
<b>Minnesota</b>		
Department of Health, Radiation Control	Radiation Control Agency	<a href="http://www.health.state.mn.us/divs/eh/radiation/index.html">http://www.health.state.mn.us/divs/eh/radiation/index.html</a>
NORM-specific Regulations	<p>Minnesota Rules, Chapter 4730, "Ionizing Radiation" and Chapter 4731, "Radioactive Materials".</p> <p>Minnesota Rules, Chapter 4731, "Radioactive Materials", are applicable to NORM-bearing materials.</p>	<p><a href="https://www.revisor.leg.state.mn.us/rules/?id=4730&amp;date=1991">https://www.revisor.leg.state.mn.us/rules/?id=4730&amp;date=1991</a></p> <p><a href="http://www.health.state.mn.us/divs/eh/radiation/rules/index.html">http://www.health.state.mn.us/divs/eh/radiation/rules/index.html</a></p>
<b>Mississippi</b>		
Department of Health	Possession, Decontamination, and Worker Protection	<a href="http://msdh.ms.gov/msdhsite/_static/resources/4620.pdf">http://msdh.ms.gov/msdhsite/_static/resources/4620.pdf</a>
State Oil & Gas Board	Oil and Gas Agency	<a href="http://www.ogb.state.ms.us/Default.htm">http://www.ogb.state.ms.us/Default.htm</a>
Mississippi Administrative Code	Statewide Rules, Rule 68, "Disposal of Naturally Occurring Radioactive Materials (NORM)" and Rule 69, "Control of Oil Field Naturally	<a href="http://www.ogb.state.ms.us/rulebook.htm">http://www.ogb.state.ms.us/rulebook.htm</a>



State / State Agency	Extent of Regulations	Website
	<p>Occurring Radioactive Materials (NORM)."</p> <p><i>Regulations for Control of Radiation in Mississippi, Title 15, Part III, Subpart 78, Chapter 1, Section 1100, "Licensing of Naturally Occurring Radioactive Materials (NORM)".</i></p> <p><i>Title 15, Part III, Subpart 78, Chapter 1, Regulations for Control of Radiation in Mississippi</i></p>	<p><a href="http://sos.ms.gov/ACProposed/00016028b.pdf">http://sos.ms.gov/ACProposed/00016028b.pdf</a></p> <p><a href="http://msdh.ms.gov/msdhsite/_static/resources/2308.pdf">http://msdh.ms.gov/msdhsite/_static/resources/2308.pdf</a></p>
<b>Missouri</b>		
<p>Department of Natural Resources, Division of Geology and Land Survey, Geological Survey Program, State Oil and Gas Council</p>	<p>Oil and Gas Agency</p>	<p><a href="http://dnr.mo.gov/geology/geosrv/ogc/index.html">http://dnr.mo.gov/geology/geosrv/ogc/index.html</a></p>
<p>Department of Health and Senior Services, Radiation Protection Program</p>	<p>Radiation Control Agency</p>	<p><a href="http://health.mo.gov/safety/radprotection/">http://health.mo.gov/safety/radprotection/</a></p>



State / State Agency	Extent of Regulations	Website
Missouri Administrative Code	<i>Code of State Regulations</i> , Title 19, Division 20, Chapter 10, "Protection Against Ionizing Radiation".	<a href="http://www.sos.mo.gov/adrules/csr/current/19csr/19csr#19-20">http://www.sos.mo.gov/adrules/csr/current/ 19csr/19csr#19-20</a>
<b>Montana</b>		
Montana Board of Oil and Gas	Oil and Gas Agency	<a href="http://bogc.dnrc.mt.gov/">http://bogc.dnrc.mt.gov/</a>
Department of Public Health and Human Services, Quality Assurance Division	Radiation Control Agency	<a href="http://dphhs.mt.gov/qad/index">http://dphhs.mt.gov/qad/index</a>
Montana Regulations	<i>Administrative Rules of Montana</i> , Title 37, Chapter 14, "Radiation Control".	<a href="http://www.mtrules.org/gateway/ChapterHome.asp?Chapter=37%2E14">http://www.mtrules.org/gateway/ChapterHo me.asp?Chapter=37%2E14</a>
<b>Nebraska</b>		
Nebraska Oil and Gas Conservation Commission	Oil and Gas Agency	<a href="http://www.nogcc.ne.gov/">http://www.nogcc.ne.gov/</a>
Department of Health and Human Services, Division of Public Health, Office of Radiological Health	Radiation Control Agency	<a href="http://dhhs.ne.gov/publichealth/Pages/puh_enh_rad_index.aspx">http://dhhs.ne.gov/publichealth/Pages/puh_ enh_rad_index.aspx</a>
Nebraska Administrative Code	<i>Nebraska Administrative Code</i> , Title 180, "Control of Radiation".	<a href="http://dhhs.ne.gov/publichealth/Pages/puh_enh_rad_regs_regindex.aspx">http://dhhs.ne.gov/publichealth/Pages/puh_ enh_rad_regs_regindex.aspx</a>
<b>Nevada</b>		
Commission on Mineral Resources, Division of Minerals, Oil, Gas, and Geothermal Programs	Oil and Gas Agency	<a href="http://minerals.nv.gov/Programs/OG/OG/">http://minerals.nv.gov/Programs/OG/OG/</a>
Department of Health and Human Services, Health Division, Bureau of Health Care	Radiation Control Agency	<a href="http://dpbh.nv.gov/Reg/Radiation_Control_Programs/">http://dpbh.nv.gov/Reg/Radiation_Control_P rograms/</a>



State / State Agency	Extent of Regulations	Website
Quality and Compliance, Radiological Health Section	NORM / TENORM Control Program	<a href="http://dpbh.nv.gov/Reg/NORM/NORM_-_Home/">http://dpbh.nv.gov/Reg/NORM/NORM_-_Home/</a>
Nevada Administrative Code	<i>Nevada Administrative Code</i> , Chapter 459, §459.118 - 459.950, "Radiation Control".	<a href="http://www.leg.state.nv.us/nac/nac-459.html">http://www.leg.state.nv.us/nac/nac-459.html</a>
<b>New Mexico</b>		
Environment Department	Possession, Decontamination, and Worker Protection	<a href="http://164.64.110.239/nmac/_title20/T20C003.htm">http://164.64.110.239/nmac/_title20/T20C003.htm</a>
Oil Conservation Department	Disposal of Oil and Gas NORM	<a href="http://www.emnrd.state.nm.us/OCD/documents/1069NORM.pdf">http://www.emnrd.state.nm.us/OCD/documents/1069NORM.pdf</a>
<b>North Dakota</b>		
Department of Health	Possession, Decontamination, and Worker Protection	<a href="http://www.ndhealth.gov/ehs/tenorm/">http://www.ndhealth.gov/ehs/tenorm/</a>
Industrial Commission	Disposal of Oil and Gas NORM	<a href="https://www.dmr.nd.gov/oilgas/">https://www.dmr.nd.gov/oilgas/</a>
North Dakota Administrative Code	<i>North Dakota Administrative Code</i> , Article 33-10, "North Dakota Radiological Health Rules".	<a href="http://www.ndhealth.gov/aaq/rad/radrules/contents.htm">http://www.ndhealth.gov/aaq/rad/radrules/contents.htm</a>
<b>Ohio</b>		
Department of Health	Possession, Decontamination, and Worker Protection	<a href="http://codes.ohio.gov/oac/3701%3A1-43">http://codes.ohio.gov/oac/3701%3A1-43</a>
Department of Health, Radiation Protection	Radiation Control Agency	<a href="http://www.odh.ohio.gov/odhPrograms/rp/radprot/radprot1.aspx">http://www.odh.ohio.gov/odhPrograms/rp/radprot/radprot1.aspx</a>



State / State Agency	Extent of Regulations	Website
Department of Natural Resources, Division of Mineral Resources Management  Oil and Gas	Oil and Gas Agency	<a href="http://apps.ohiodnr.gov/home/index.aspx">http://apps.ohiodnr.gov/home/index.aspx</a>
Ohio Administrative Code	<i>Ohio Administrative Code</i> , Chapter 3701, "Radiation Protection Rules and Regulations".	<a href="http://codes.ohio.gov/oac/3701">http://codes.ohio.gov/oac/3701</a>
<b>Oklahoma</b>		
Oklahoma Corporation Commission, Oil and Gas Conservation Division	Oil and Gas Agency	<a href="http://www.occeweb.com/og/oghome.htm">http://www.occeweb.com/og/oghome.htm</a>
Department of Environmental Quality, Land Protection Division, Radiation Management Section	Radiation Control Agency	<a href="http://www.deq.state.ok.us/lpdnew/radindex.html">http://www.deq.state.ok.us/lpdnew/radindex.html</a>
Oklahoma Administrative Code	<i>Oklahoma Administrative Code</i> , Title 252, Chapter 410, "Radiation Management".	<a href="http://www.deq.state.ok.us/rules/410.pdf">http://www.deq.state.ok.us/rules/410.pdf</a>
<b>Oregon</b>		
Department of Geology and Mineral Industries	Oil and Gas Agency	<a href="http://www.oregongeology.org/sub/default.htm">http://www.oregongeology.org/sub/default.htm</a>
Department of Human Services, Radiation Protection Services	Radiation Control Agency	<a href="https://public.health.oregon.gov/HealthyEnvironments/RadiationProtection/Pages/index.aspx">https://public.health.oregon.gov/HealthyEnvironments/RadiationProtection/Pages/index.aspx</a>



State / State Agency	Extent of Regulations	Website
Oregon Rules and Statutes	<p><i>Oregon Administrative Rules, Chapter 333, Division 117, "Regulations and Licensing of Naturally Occurring Radioactive Materials".</i></p> <p><i>Oregon Administrative Rules, Chapter 333, Divisions 100-120, "Control of Radiation in Oregon".</i></p>	<p><a href="https://public.health.oregon.gov/HealthyEnvironments/RadiationProtection/Pages/rules.aspx">https://public.health.oregon.gov/HealthyEnvironments/RadiationProtection/Pages/rules.aspx</a></p> <p><a href="http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_333/333_tofc.html#117">http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_333/333_tofc.html#117</a></p> <p><a href="http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_333/333_100.html">http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_333/333_100.html</a></p>
<b>South Dakota</b>		
Department of Environment and Natural Resources, Minerals and Mining Program, Oil and Gas Section	Oil and Gas Agency	<a href="http://denr.sd.gov/des/og/oghome.aspx">http://denr.sd.gov/des/og/oghome.aspx</a>
Department of Health  Licensure and Certification	Radiation Control Agency	<a href="http://doh.sd.gov/error.aspx?aspxerrorpath=/Licensure/Radioactive.aspx">http://doh.sd.gov/error.aspx?aspxerrorpath=/Licensure/Radioactive.aspx</a>
South Dakota Administrative Rules	<i>South Dakota Administrative Rules, Title 44, Article 3:01, "Radiation Control".</i>	<a href="http://sdlegislature.gov/rules/DisplayRule.aspx?Rule=44:03:01">http://sdlegislature.gov/rules/DisplayRule.aspx?Rule=44:03:01</a>
<b>Tennessee</b>		
Department of Environment and Conservation, Division of Geology	Oil and Gas Agency	<a href="https://www.tn.gov/environment/section/geo-geology">https://www.tn.gov/environment/section/geo-geology</a>
Department of Environment and Conservation, Division of Radiological Health	Radiation Control Agency	<a href="http://www.tennessee.gov/environment/section/rh-radiological-health">http://www.tennessee.gov/environment/section/rh-radiological-health</a>



State / State Agency	Extent of Regulations	Website
Tennessee Administrative Code	<i>Rules and Regulations of the State of Tennessee</i> , Chapter 1200-2, "State Regulations for Protection Against Radiation".	<a href="https://www.nrc.gov/docs/ML0828/ML082880587.pdf">https://www.nrc.gov/docs/ML0828/ML082880587.pdf</a>
<b>Texas</b>		
Department of State Health Services	Possession, Decontamination, and Worker Protection	<a href="http://www.dshs.texas.gov/radiation/laws-rules.aspx">http://www.dshs.texas.gov/radiation/laws-rules.aspx</a>  <a href="http://www.dshs.texas.gov/radiation/default.shtm">http://www.dshs.texas.gov/radiation/default.shtm</a>
Railroad Commission	Disposal of Oil & Gas NORM	<a href="http://texreg.sos.state.tx.us/public/readtac\$ext.ViewTAC?tac_view=5&amp;ti=16&amp;pt=1&amp;ch=4&amp;sch=F&amp;rl=Y">http://texreg.sos.state.tx.us/public/readtac\$ext.ViewTAC?tac_view=5&amp;ti=16&amp;pt=1&amp;ch=4&amp;sch=F&amp;rl=Y</a>
Texas Administrative Codes	<i>Texas Administrative Code</i> , Title 16, Part I, Chapter 4, Subchapter F, "Oil and Gas NORM".  <i>Texas Administrative Code</i> , Title 25, Part I, Chapter 289.259, "Licensing of Naturally Occurring Radioactive Material (NORM)".  <i>Texas Administrative Code</i> , Title 25, Part I, Chapter 289, "Radiation Control".	<a href="https://texreg.sos.state.tx.us/public/readtac\$ext.ViewTAC?tac_view=5&amp;ti=16&amp;pt=1&amp;ch=4&amp;sch=F&amp;rl=Y">https://texreg.sos.state.tx.us/public/readtac\$ext.ViewTAC?tac_view=5&amp;ti=16&amp;pt=1&amp;ch=4&amp;sch=F&amp;rl=Y</a>  <a href="https://texreg.sos.state.tx.us/public/readtac\$ext.TacPage?sl=R&amp;app=9&amp;p_dir=&amp;p_rloc=&amp;p_tloc=&amp;p_ploc=&amp;pg=1&amp;p_tac=&amp;ti=25&amp;pt=1&amp;ch=289&amp;rl=259">https://texreg.sos.state.tx.us/public/readtac\$ext.TacPage?sl=R&amp;app=9&amp;p_dir=&amp;p_rloc=&amp;p_tloc=&amp;p_ploc=&amp;pg=1&amp;p_tac=&amp;ti=25&amp;pt=1&amp;ch=289&amp;rl=259</a>  <a href="http://www.dshs.texas.gov/radiation/laws-rules.aspx">http://www.dshs.texas.gov/radiation/laws-rules.aspx</a>
Texas Commission of Environmental Quality	Disposal of Non-Oil & Gas NORM	<a href="http://www.tceq.texas.gov/permitting/radmat/uranium/norm.html">http://www.tceq.texas.gov/permitting/radmat/uranium/norm.html</a>
<b>Washington</b>		
Department of Natural Resources,	Oil and Gas Agency	<a href="http://www.dnr.wa.gov/geology">http://www.dnr.wa.gov/geology</a>



State / State Agency	Extent of Regulations	Website
Division of Geology and Earth Resources		
Washington State Department of Health, Office of Radiation Protection	Radiation Control Agency	<a href="http://www.doh.wa.gov/CommunityandEnvironment/Radiation">http://www.doh.wa.gov/CommunityandEnvironment/Radiation</a>
Washington Administrative Code	<i>Washington Administrative Code</i> , Title 246, Chapters 246-220 through 246-254, "Radiation".	<a href="http://app.leg.wa.gov/wac/default.aspx?disp_o=true&amp;cite=246">http://app.leg.wa.gov/wac/default.aspx?disp_o=true&amp;cite=246</a>
<b>West Virginia</b>		
Department of Health and Human Resources	Possession, Decontamination, and Worker Protection	<a href="https://www.wvdhhr.org/rtia/radiological_health.asp">https://www.wvdhhr.org/rtia/radiological_health.asp</a>
<b>Wisconsin</b>		
Department of Health and Family Services, Radiation Protection Section	Radiation Control Agency	<a href="https://www.dhs.wisconsin.gov/radiation/index.htm">https://www.dhs.wisconsin.gov/radiation/index.htm</a>
Wisconsin Administrative Code	<i>Wisconsin Administrative Code</i> , Chapter 254, Subchapter III, Section 31 through 45, "Radiation Protection".	<a href="http://docs.legis.wisconsin.gov/statutes/statutes/254/III/31">http://docs.legis.wisconsin.gov/statutes/statutes/254/III/31</a>
<b>Wyoming</b>		
Wyoming Oil and Gas Conservation Commission	Oil and Gas Agency	<a href="http://wogcc.wyo.gov/">http://wogcc.wyo.gov/</a>



## Appendix B

### NORM in the Gas Transmission and Storage Industry

#### What is NORM?<sup>1</sup>

NORM, or naturally occurring radioactive material, is found almost everywhere. It is found in the air and in soil, and even in radioactive potassium in our own bodies. It is found in public water supplies and foods such as Brazil nuts, cereal, and peanut butter.

The average person in the United States is exposed to about 360 millirems of radiation from natural sources each year. A millirem, or one one-thousandth of a rem, is a measure of radiation exposure. More than 80% of this exposure level comes from background radiation sources primarily radon.

Health risks from exposure to low levels of NORM are low. However, activities involving the extraction, mining, beneficiating, processing, use, transfer, transport, storage, disposal, and/or recycling of NORM-containing or NORM-contaminated materials may increase exposure levels to workers and other individuals to levels of concern. Human activities such as petroleum refining, natural gas extraction, water treatment, and mining can alter the natural background radiation.

#### NORM in the Oil and Gas Field

NORM encountered in oil and gas exploration, development, production, and operations originate in subsurface formations, which may contain radioactive materials such as uranium and thorium and their daughter products, Radium-226 and Radium-228. NORM can be brought to the surface in the formation water that is produced in conjunction with oil and gas. NORM in these produced waters typically consists of the radionuclides, Radium-226 and 228. In addition, radon gas, a radium daughter, may be found in produced natural gas.

Because the levels are typically low, NORM in produced waters and natural gas is not a problem unless it becomes concentrated in some manner. Through temperature and pressure changes that occur in the course of oil and gas production operations, Radium-226 and 228 found in produced waters may co-precipitate with barium sulfate scale in well tubulars and surface equipment. Concentrations of Radium-226 and 228 may also occur in sludge that accumulates in oilfield vessels, pits and tanks. These solids become sources of oil and gas NORM waste. In gas processing activities, NORM generally occurs as radon gas in the natural gas stream. Radon-222 decays to Lead-210, then to Bismuth-210, Polonium-210, and finally to stable Lead-206. Radon-222 decay elements occur as a film on the inner

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<sup>1</sup> Adapted from <http://www.rrc.state.tx.us/oil-gas/applications-and-permits/environmental-permit-types-information/norm/>



surface of downhole tubulars, wellheads, manifolds, meter systems, inlet lines, treating units, pumps, and valves principally associated with propylene, ethane, and propane processing streams.

**NORM in Natural Gas Transmission and Storage**

Natural gas in interstate natural gas pipelines and storage facilities has already been processed and almost all produced water and deleterious material has been removed. Some traces of radioactive Radon-222 may remain. Some of this radioactive radon may be further attenuated by “straddle plants”, owned by third parties that remove ethane, propane and other constituents from the natural gas; radon behaves like propane and may be from in the natural gas stream along with the ethane and propane. The remaining Radon-222 decays to radioactive Lead 210 within a few days. This radioactive Lead-210 has a half-life of over twenty years and is distributed within the pipeline, sometimes concentrating in inline filters, scrubbers, pumps, manifolds, valves and drips and during pipe cleaning activities called pigging. Lead-210 decays slowly to Bismuth-210, then Polonium-210, and finally stable Lead-206 by losing beta and alpha particles, which are not truly harmful in the quantities encountered unless they enter the body through inhalation, ingestion, or through absorption through the skin, and entry through a cut or wound in the skin.

**ALARA and Environmental Protection**

Regardless of the small quantities of NORM generated by the natural gas transmission and storage industry, and the low risk of the radioactive particles entering the body and doing harm, our industry subscribes to the principle of ALARA when dealing with any ionizing radiation. ALARA means “As Low As Reasonably Achievable” and refers to minimizing the exposure of our workers and the general public to radiation. Our companies, staff, and contractors follow international, federal, state and industry rules and guidelines whenever dealing with NORM. These rules and guidelines implement the principle of ALARA and ensure appropriate waste management rules that protect our workers and contractors, the general public and the environment.

**Worker and Contractor Protection<sup>2</sup>**

Many states have NORM-specific regulations that must be followed closely and will adequately protect workers. Even jurisdictions without NORM-specific regulation follow general ionizing regulations, which are protective of worker health.

All equipment suspected of being NORM contaminated must be surveyed on external surfaces, using a properly calibrated sodium iodide scintillation detector, and on interior surfaces using a Geiger-Mueller pancake detector. Any equipment emitting more than 2,000 µR/h or 20 µSv/h of radiation is hazardous, and the area must be evacuated until the radiation level is consistently below these limits or until evaluated by a radiation expert (holding a Specific License in states with NORM-specific

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<sup>2</sup> Adapted from *Guide Naturally Occurring Radioactive Materials (NORM)*, June 2000, Canadian Association of Petroleum Producers.



regulations. Any equipment reading above 50  $\mu\text{R}/\text{h}$  or 0.5  $\mu\text{Sv}/\text{h}$  or two times the background radiation is considered NORM-contaminated and is managed following company rules.

Work procedures are recommended when maintaining NORM-contaminated equipment and materials such as pipelines, filters, pumps, lines, sludge or wellhead equipment. The exposure risk is highest when grinding, cutting, polishing or performing other work that may generate dust. Get good technical advice if you suspect a NORM problem. If there is NORM contamination, all employees should attend a NORM training course. The work procedures should include provisions for:

Equipment hazard evaluation when the equipment is opened. The evaluation should include the use of gamma detectors, pancake probe measurements and lab analysis for activity and identification of the isotope.

- Protection of workers from external gamma radiation, if necessary.
- Protection of workers from NORM contaminated **dust**.
- Controlling the spread of contamination.
- Waste classification to ensure NORM is controlled while minimizing waste volume.
- Transportation safety for any NORM materials shipped offsite, following US Department of Transport 49CFR173 or Transport **Canada, and State or compact rules**.

#### Further Information

- <http://www.rrc.state.tx.us/oil-gas/applications-and-permits/environmental-permit-types-information/norm/>
- *Guide Naturally Occurring Radioactive Materials (NORM)*, June 2000, Canadian Association of Petroleum Producers.
- <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/environmental-contaminants/canadian-guidelines-management-naturally-occurring-radioactive-materials-norm-health-canada-2000.html>
- <https://pubs.usgs.gov/fs/fs-0142-99/fs-0142-99.pdf>
- <https://www.osha.gov/SLTC/oilgaswelldrilling/healthhazards.html#norm>
- [https://www.osha.gov/dts/hib/hib\\_data/hib19890126.html](https://www.osha.gov/dts/hib/hib_data/hib19890126.html)
- [http://nuclearsafety.gc.ca/pubs\\_catalogue/uploads/NORM-factsheet-eng.pdf](http://nuclearsafety.gc.ca/pubs_catalogue/uploads/NORM-factsheet-eng.pdf)



APPENDIX C:

**SAFETY DATA SHEET**

**NATURALLY OCCURRING RADIOACTIVE  
MATERIAL (NORM)**

Rev. Date  
05/08

**IMPORTANT:** read this SDS before handling and disposing of this product and pass this information on to employees, customers, and users of this product.

<b>1. GENERAL</b>		
<b>MATERIAL IDENTITY</b>	Naturally Occurring Radioactive Material (NORM)	
<b>COMMON NAME(S) and SYNONYMS</b>	Technically Enhanced Naturally Occurring Radioactive Material (TENORM)	
<b>CHEMICAL FAMILY</b>	U-238 and Th-232	
<b>CHEMICAL FORMULA</b>	N/AP	
<b>CAS NUMBER</b>	N/AP	
<b>US DOT DESCRIPTION</b>	NORM ID No. UN2910; UN2912	
<b>TELEPHONE NUMBERS</b>	<b>EMERGENCY SERVICES</b> ALMAC Environmental Services (281) 948-0995; (832) 794-5922 (281) 648-2088	<b>GENERAL ASSISTANCE (M-F)</b> ALMAC Environmental Services, (832) 794-5922 (281) 648-2088
<b>PREPARATION DATE:</b>	August 2005	
<b>REVISION DATES:</b>	May 2008	
<b>NFPA/HMIS:</b>		
<b>Hazard Rating</b>	<b>NFPA</b>	<b>HMIS</b>
4 – Extreme		
3 – High	Fire 0	Fire 0
2 – Moderate	Health 1	Health 1
1 – Slight	Reactivity 0	Physical Hazard 0
0 – Insignificant		
<b>2. IMMEDIATE HAZARDS</b>		
Contaminated materials are an external and internal hazard, in particular, when material is airborne.		



### 3. COMPONENTS AND EXPOSURE LIMITS

COMPONENT	CAS NUMBER	APPROXIMATE CONCENTRATION
TENORM forms as radioactive scale, surface coating and solids in Oil and Gas Production, Processing, Transmission and Refining facilities. Other Hazard information is addressed separately as appropriate. TENORM concentration units of radioactivity are Becquerel per gram and (picoCuries per gram). Any NORM present in this material will consist of naturally occurring Radium 226 and/or Thorium 232 and/or associated decay products including radon gas.	N/AP	Radium 226 and Thorium 232 range from < 0.04 – 67 Becquerels/gram (1 to 1800 picoCuries per gram), Lead 210 found to 1-40,000Bq/g (27-1.1 µCuries/gram) Decay products may be present in equilibrium activity levels depending on contaminant of emanated radon gas.

OCCUPATIONAL EXPOSURE LIMITS FOR TOTAL PRODUCT	BASIS
Radiation worker Occupational whole-body exposure TEDE should not exceed 50mSv (5 rem) per year.	NRC 10 CFR 20
Occupationally exposed non-radiation worker whole body exposure TEDE should not exceed (5mSv) (0.5 rem) per year.	25TAC289.202
General public Occupational whole-body exposure TEDE should not exceed (1mSv) (0.1 rem) per year.	
Threshold Limit Values (TLVs - ACGIH) – Accepts the occupational exposure guidance of the National Council on Radiation Protection (NCRP) for ionizing radiation.	
The limits indicated above are generally expressed as total effective dose equivalents (TEDE) which is the sum of the deep dose equivalent for external radiation and the committed effective dose equivalent for internal exposure. Limits for radioactive materials in air and water can be found in 10 CFR Part 20, Table I of Appendix B.	

### 4. FIRE AND EXPLOSION

FLASH POINT (Cleveland Closed Cup)	AUTOIGNITION TEMP.	FLAMMABLE LIMITS (% VOLUME IN AIR)
N/AP	N/AP	LOWER: N/AP UPPER: N/AP
FIRE AND EXPLOSION HAZARDS	This product is not a flammable or combustible material. It is found in NGLs (>7% propane) and propane pipelines.	
EXTINGUISHING MEDIA	Dry chemical, carbon dioxide, water spray, fog or regular foam (dependent upon contaminated material).	
SPECIAL FIREFIGHTING PROCEDURES	Avoid breathing smoke, fume or dust. Use self-contained breathing apparatus whenever NORM contaminated material is suspected.	



## **5. HEALTH HAZARDS – EFFECTS OF OVEREXPOSURE**

TARGET ORGAN	Respiratory System, liver, kidneys spleen and bone marrow.
PRIMARY HEALTH EFFECT	Pulmonary Fibrosis
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE	Any lung irritation or pre-existing symptoms
CARCINOGEN CLASSIFICATIONS	Not listed as carcinogenic by OSHA, IARC or NTP
NATURE OF HAZARD AND TOXICITY INFORMATION	The principle hazard from NORM is from ionizing radiation particularly the potential inhalation and/or ingestion of airborne radioactive particles. Radioactive particles in air or radon gas attached to dust particles may be inhaled and deposited in the trachea, bronchial tree or lungs. In individuals exposed to high cumulative doses of radioactive particles or radon gas in air the ionizing radiation may induce metaplasia and atypical cell growth in the trachea or bronchial epithelium, which may develop into bronchial carcinoma. Radiation to terminal airways may lead to emphysema and pulmonary fibrosis. The frequency of carcinoma is greatly increased, and the latent period is decreased when exposed persons smoke cigarettes. The risk of cancer in exposed populations is greatly dependent on the amount of cumulative exposure, time since beginning of exposure, frequency of exposure, age, amount of cigarette smoking, and chest size. The amount of cumulative airborne exposure to NORM resulting from oil and gas operations is expected to be very low with an associated low risk of related illnesses. High cumulative exposures to direct gamma radiation are not expected in association with NORM oil and gas operations. However, these exposures should be evaluated and limited to below the permissible limits (see Section 3).
SIGNS AND SYMPTOMS OF EXPOSURE	NORM has no odor or taste associated with its radioactivity and will have no associated signs or symptoms of exposure. At ionizing radiation levels encountered in oil and gas operations, no acute signs, symptoms or effects of exposure are expected.

## **6. PROTECTIVE EQUIPMENT / CONTROL MEASURES**

RESPIRATORY	Respiratory protection is required during normal use until air monitoring data confirms NIOSH approved air purifying respirator with organic vapor cartridges are not required.
EYE	Eye protection should be worn. Chemical goggles should be worn if material is airborne.
SKIN	Normal working clothes should be worn. Wash contaminated clothing prior to reuse. Wash all NORM from exposed skin.



ENGINEERING CONTROLS	Work in well ventilated areas. Use non-sparking tools where liquids or vapors from the oil or condensate contamination may be generated at flammable concentrations.
OTHER HYGIENIC AND WORK PRACTICES	Use good personal hygiene practices. If skin contact should occur, material should be washed away with a mild soap and water. Wash hands and other exposed areas thoroughly before eating, drinking, smoking or using toilet facilities. Do not smoke, drink or eat in areas where this product is stored or handled.
EXTENSIVE SCALE OR CONTAMINATION PROTECTIVE EQUIPMENT AND HANDLING PROCEDURES	For extensive scale or contamination removal, the following precautions should be taken: the work area should be well-ventilated, and access should be restricted, surface contaminants should be kept wet, plastic ground cover should be used to contain contaminants and facilitate clean-up, and high efficiency particulate respirators should be worn until air sampling results confirm they are not required. Disposable coveralls and gloves should be worn over normal work clothing and contaminated protective equipment and clothing should be decontaminated or disposed of.
PERSONAL AND AREA MONITORING	A controlled work area and contamination reduction zone should be set up and all exiting personnel and or items monitored and decontaminated to < twice the local background contamination level measuring in cpm. A detector able to measure Alpha, beta and radiation will be used for the exit surveys. Workers of companies holding a radioactive materials license will wear badges to detect beta and gamma radiation over a period of time.

<b>7. EMERGENCY AND FIRST AID</b>	
INHALATION	Immediately remove personnel to area of fresh air. For respiratory distress, give oxygen, rescue breathing, or administer CPR (cardiopulmonary resuscitation) if necessary. Obtain prompt medical attention.
EYE CONTACT	Flush eyes with clean, low-pressure water for at least 15 minutes, occasionally lifting the eyelids. Do not use hot water.
SKIN CONTACT	In case of skin contact, thoroughly wash affected area with soap and water. NORM is not readily soluble and will be absorbed in health hazardous amounts through skin contact but can enter the body through open cuts or wounds. These cuts or wounds should be covered or bandaged prior to contact with NORM in scale or sludge. Lead-210 in gas NORM is soluble in body fluids and ingestion/inhalation prevented.
INGESTION	Precautions should be taken to avoid ingestion of NORM following skin contact through good hygiene practice. Respiratory use is required until air monitoring results confirm this to be unnecessary.
SPECIAL INSTRUCTIONS	None
PRE-EXISTING CONDITIONS	Pre-existing respiratory disorders may be aggravated by exposure to components of this product.



**8. SPILL AND DISPOSAL**

<b>PRECAUTIONS IF MATERIAL IS SPILLED OR RELEASED</b>	If NORM material is spilled or released, steps should be taken to contain or prevent discharges to streams, waterways, or sewer systems and to control or stop release of NORM material into the air as dust. Clean up should be initiated and continued until residual radioactivity levels return to either background levels or levels established by local, state or federal regulatory agencies.
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<b>WASTE DISPOSAL METHODS</b>	Consult local, state and federal regulations for details on compliance. Prevent spread of contamination.
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**9. PHYSICAL, CHEMICAL AND REACTIVITY DATA**

(Note: Data varies with source, treatment and shipping methods.)

<b>BOILING RANGE</b> N/AP	<b>PH</b> N/AP
<b>FREEZING POINT</b> N/AP	<b>DRY POINT</b> N/AP
<b>SPECIFIC GRAVITY (H2O = 1 @ 39.2 °F)</b> N/AP	<b>VOLATILE CHARACTERISTICS</b> N/AP
<b>VISCOSITY UNITS, TEMP</b> N/AP	<b>SOLUBILITY IN WATER</b> N/AP
<b>VAPOR PRESSURE (Method)</b> N/AP	<b>STABILITY</b> Stable
<b>VAPOR SP GR (AIR = 1 AT 60 - 90 °F)</b> N/AP	<b>HAZARDOUS POLYMERIZATION</b> N/AP
<b>OTHER CHEMICAL REACTIVITY</b>	N/AP
<b>OTHER PHYSICAL AND CHEMICAL PROPERTIES</b>	N/AP
<b>APPEARANCE AND ODOR</b>	Dependent upon material contaminated (e.g. sludge, scale, soil, etc.)
<b>CONDITIONS TO AVOID</b>	N/AP
<b>MATERIALS TO AVOID</b>	N/AP
<b>HAZARDOUS DECOMPOSITION PRODUCTS</b>	None from typical thermal decomposition; normal radioactive decay will occur.



**10. ADDITIONAL PRECAUTIONS**

**HANDLING, STORAGE AND  
DECONTAMINATION  
PROCEDURES**

Store in isolated areas to which access can be controlled or limited. These areas should be clearly posted and identifiable. These areas should be surveyed as often as necessary to ensure exposure limits are not exceeded. NORM should be packaged to minimize its release into the environment.

Do not handle near food or drinking water. Wash after handling and shower at end of work period.

**GENERAL COMMENTS**

Follow good hygiene and handling procedures to prevent any unnecessary contact with NORM.

**11. REGULATORY INFORMATION**

**TRANSPORTATION INFORMATION:**

NORM from oil and gas operations will generally not be identified as radioactive material under DOT definition (49 CFR 193.403) since the specific activity of the Oil field NORM will be below 100 Bq/gram (2,700 picoCuries/gram). In gas operations NORM may frequently have a specific activity greater than 100 Bq/g (2,700 picoCuries/gram) and should be treated as low specific activity radioactive material under DOT (49 CFR 173.425). In either case, NORM material should be shipped as UN2910 or UN2912 in such a way that anyone handling this material is familiar with its potential hazards. Good hygiene precautions and measures should be taken to prevent the release of the NORM during shipment.

**SPECIAL LABELING INFORMATION:**

Posting and labeling should be in accordance with OSHA (29 CFR 1910.96(e)) and DOT (49 CFR 173.425), as appropriate (dependent upon the material contaminated).

<b>Abbreviations:</b>	<b>EQ = equal</b>	<b>AP = approximately</b>	<b>N/AP = not applicable</b>
	<b>LT = less than</b>	<b>UK = unknown</b>	<b>N/DA = no data available</b>
	<b>GT = greater than</b>	<b>TR = trace</b>	<b>N/P = no applicable information found</b>



<b>ACGIH</b>	American Conference of Governmental Industrial Hygienists
<b>CAS</b>	Chemical Abstracts Service (number)
<b>CFR</b>	Code of Federal Regulations
<b>DOT</b>	Department of Transportation
<b>EPA</b>	Environmental Protection Agency
<b>HMIS</b>	Hazardous Material Identification System by Paint and Coating Manufacturers Association
<b>IARC</b>	International Agency for Research on Cancer
<b>IDLH</b>	Immediately Dangerous to Life and Health
<b>NCRP</b>	National Council on Radiation Protection
<b>NFPA</b>	National Fire Protection Association
<b>NIOSH</b>	National Institute of Occupational Safety and Health
<b>NRC</b>	Nuclear Regulatory Commission
<b>NTP</b>	National Toxicology Program
<b>OSHA</b>	Occupational Safety and Health Administration
<b>PEL</b>	Permissible Exposure Limit (OSHA)
<b>SARA</b>	Superfund Amendments and Reauthorization Act
<b>STEL</b>	Short Term Exposure Limit (15 minute maximum)
<b>TLV</b>	Threshold Limit Value (ACGIH)
<b>TSCA</b>	Toxic Substance Control Act
<b>TWA</b>	Time Weighted Average
<b>UN</b>	United Nations

**DISCLAIMER OF LIABILITY**

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**For Industrial Use Only**



APPENDIX D: Work Flow

