

	NORM HANDLING PROCEDURE ALL-HSE-PRC-150	Retention Code: CG01-CA
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1.0 Purpose

The purpose of this procedure is to minimize exposure to radiation from naturally occurring radioactive materials (NORM) and to assist ConocoPhillips operations and facilities in complying with applicable legislation.

2.0 Context and Scope

This procedure applies to workers at all ConocoPhillips-operated sites and to all ConocoPhillips employees providing services to sites operated by other companies.

3.0 Hazards

NORM can be present in various process streams and can produce three types of radiation:

- Alpha;
- Beta; and
- Gamma.

All three types of radiation can cause human tissue damage and present an increased risk of cancer internally and externally to the human body.

The external radiation (radiation outside the human body) risk from NORM inside process equipment is generally not a concern. However, when equipment is opened for cleaning or maintenance, exposure to NORM may occur if it is present as a dust, sludge or friable scale. The **intake** of NORM into the body (internal radiation) is usually the greatest risk of NORM exposure.

4.0 Roles and Responsibilities

4.1. Supervisor/Management

- a) Work with CPC industrial hygienist to ensure that all operations and locations where radiation hazards exist have been identified, assessed, signed/labelled and documented.
- b) Ensure that NORM management plans are implemented if NORM is present.
- c) Ensure that equipment removed from NORM-contaminated sites is checked for NORM contamination before maintenance or cleaning is performed, whether this is to be done by ConocoPhillips or by an external contractor. Inform all parties concerned if NORM is present.
- d) Refer requests for reproductive hazards assessments from workers to CPC's industrial hygienist.

4.2. Workers

- a) Follow the requirements from this procedure and implement the NORM management plan where one has been developed.
- b) Inform supervisors of any suspected sources of radiation exposure not previously documented.
- c) Use appropriate personal protective clothing and equipment (including respiratory protection), where necessary, and maintained in a clean and operable condition.

4.3. Industrial Hygienist

- a) Identify areas that have NORM and notify operations personnel.
- b) Verify that signage has been added where NORM is present.
- c) Develop NORM management plans as needed.
- d) Report and notify appropriate governing bodies of any NORM-related limits that have been exceeded.

Saskatchewan Radiation Health and Safety Regulations	An officer of the Saskatchewan Government be notified if a non-radiation worker is exposed to external radiation above 0.25 mSv (250 uSv).
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5.0 General Information on NORM

5.1. Potential NORM Locations

NORM may be present in many locations, including:

- Produced water, crude oil, crude oil emulsion, and natural gas;
- Well bore perforations;
- Well tubulars;
- Wellheads;
- Down-hole pumps;
- Gas and oil transmission lines (especially in filters);
- Gathering and processing facilities: especially meters, impeller blades, valves, knockout vessels, filters, screens, pumps, tanks and elbows;
- Propane pumps and bullets;
- Ethane systems; and
- Barium and/or strontium scales or sludges.

Process changes can affect NORM deposition rates. Any conditions causing entrained materials to precipitate out can cause NORM deposition such as:

- Changes in flow direction;
- Changes in pressure constrictions;
- Well casing leakage allowing contamination by formation water; and
- Where fractionation of natural gas occurs, NORM can concentrate in the propane-rich and ethane-rich streams.

NORM deposits may vary from well to well and from week to week. The risk of NORM deposition may increase by the use of:

- Enhanced oil recovery techniques;
- The addition of new production wells;
- Accepting third party production; and
- Changing chemical additives.

6.0 NORM Measurement and Classification

6.1. Measurement

Types of monitoring include:

- Alpha/beta measurement inside equipment;
- Personal dosimetry;
- Radon gas measurement; and
- Airborne NORM dust exposure monitoring.

To avoid surprises and unnecessary production delays, operations may consult with the industrial hygienist to determine if external gamma surveys of gathering and producing should be conducted at facilities before turnarounds so that temporary NORM storage can be arranged if needed.

1. Determine the background reading for the location. These can vary and may affect measurements.
2. Use gamma readings on the outside of equipment to determine if NORM is present inside. It is an approximate measurement designed only to locate NORM.
3. Make sure the system is in operation when taking external readings. Only the short-lived "daughter" isotopes of radon can be measured outside the equipment. After one to two hours, NORM cannot be detected externally.
4. Identify readings of twice background or more. These indicate NORM. Further measurements and possibly sampling for laboratory analysis may be required to better determine the risk level and need for precautions.
5. If NORM has been detected at the site, work with the industrial hygienist to complete internal pancake probe measurements when the equipment is next opened (e.g., at turnaround). If possible, also collect scale or sludge samples and submit them to an approved laboratory for gamma spectroscopy analysis.
6. Provide measurement results to the industrial hygienist.

For vessel entry, comply with confined space entry requirements, take gamma radiation measurements inside when safe to do so, and restrict time inside as necessary.

6.2. Classification

6.2.1. External Gamma Measurements

Where NORM readings measure twice the background count and above complete further analysis (i.e., internal measurement) when the equipment is next opened, for example during maintenance or at turnaround.

6.2.2. Internal Measurements (using radiation meter with pancake probe)

- Less than twice the background – non-restricted, no requirements¹.
- Less than 200 counts per minute (cpm) - no action required to protect workers (although disposal may be restricted if greater than twice the background - see footnote).
- 200 -1500 counts per minute (cpm) - NORM is present
- Above 1500 cpm - material is probably in the radioactive classification, requires further assessment and is subject to Transportation of Dangerous Goods Regulations (contact the ConocoPhillips HSE Specialist).

7.0 Precautions for Minimizing Exposure to NORM

If there is a chance of workers coming into contact with NORM, ConocoPhillips Industrial Hygienist must be contacted and a NORM management plan must be developed and be implemented.

7.1. General Precautions

1. Minimize time spent in area.
2. Keep as far away from the NORM-contaminated material/equipment as possible. Keep NORM material at arm's length from the body, wherever possible.
3. Minimize dust generation; don't grind, chip or sand scale.
4. Minimize contamination of clothing.
5. Cover all cuts and abrasions on skin.
6. Do not eat, drink or smoke in a potentially contaminated work area.
7. Label all vessels/equipment that contain NORM with:

**Warning - Naturally Occurring Radioactive Materials (NORM)
Wear Respirator to Avoid Breathing Dust**

¹ The Canadian NORM Guidelines limit for unrestricted disposal of NORM is an activity of 0.3 Bq/g or less. This level of activity is at the lower limit of detection of most pancake probes, but can be detected using an Inspector. Although only approximate, the best direct reading estimate of 0.3 Bq/g on site is a measurement of twice the background.

7.2. Personal Protective Equipment (PPE)

Use the following PPE for handling NORM, where the risk of inhalation of NORM dust/mist is minimal (i.e., materials are wet or otherwise dust generation is insignificant):

- Impervious gloves (e.g., Viton, nitrile, neoprene);
- Wear fire-retardant disposable coveralls if possible;
- Rubber or neoprene boots (or disposable boot covers if area is dry); and
- Safety glasses/goggles.

In addition, wear a minimum of a half facepiece P100 (HEPA) cartridge respirator when handling dry NORM-contaminated sludges or dust, dusty scale or other operations where dust inhalation can occur.

7.3. Decontamination

1. Wash hands, forearms and face thoroughly at the end of work and before eating, drinking or smoking.
2. Remove contaminated clothing and PPE.
3. Check contamination of workers' hands and clothing using a radiation meter equipped with a pancake probe. If counts are greater than twice the background level, repeat washing to get down to less than twice the background.
4. Wash or discard contaminated PPE as NORM-contaminated waste.

8.0 Storage, Labeling and Cleaning of NORM

The objective of storage is to prevent NORM from becoming airborne or being washed onto the ground by rain.

1. Seal all contaminated equipment to prevent leakage of NORM until cleaning or disposal. Options include bull plugs, blind flanges, and wrapping/taping in polyethylene sheeting or tarp. Welding steel plates over openings is another alternative. However, welding may give off fine NORM dust or fume. Use a high efficiency particulate (P100, HEPA) respirator and disposable coveralls for this work. For advice, contact the industrial hygienist.
2. Label all NORM-contaminated equipment, packages and containers with the wording "Warning – Naturally Occurring Radioactive Materials (NORM) – Wear Respirator to Avoid Breathing Dust". Include the date the container was filled and surface gamma radiation measurements made.
3. Store NORM in a secure location away from normal operations until transportation can be arranged. NORM-contaminated equipment can be cleaned and returned to service. Contact ConocoPhillips HSE Department regarding which NORM may be cleaned by ConocoPhillips personnel and which requires outside services (e.g., Normcan Control Inc.'s facility in Standard, AB performs cleaning of NORM-contaminated equipment.)
4. Ensure that contractors servicing well or processing equipment have their own radiation meters to check for NORM contamination on equipment brought into their shops.

9.0 Disposal of NORM

If disposal options are being considered, please contact HSE Performance Assurance.

9.1. Disposition of equipment

ConocoPhillips does not dispose, sell, recycle, give or donate used oilfield equipment to the public or other companies unless it has passed the following criteria:

- Equipment/piping has been properly cleaned of internal/external oilfield products (e.g., sludge/oil/scale/other residue).
- Has been scanned for NORM contamination and managed as required based upon remaining contaminate levels.

10.0 Transportation of NORM

If the transportation of NORM waste of NORM contaminated equipment is required, please contact HSE Performance Assurance for further instructions.

11.0 NORM Management Plans

Develop specific NORM Management Plans with procedures wherever NORM is present. Examples include:

- Opening surface equipment;
- Vessel entry;
- Service rig operations; and
- Bottom hole pump servicing.

12.0 Document Retention

Records must be retained in accordance with ConocoPhillips' document retention schedule.

Record	Owner	Classification	Retention
Exposure monitoring and measurement	Industrial Hygiene Specialist	HSE200	30 years
Employee medical records including medical exposure surveillance, audiometric testing, etc.	Occupational Health Nurse	HRB420	End of employment + 30 years

13.0 Glossary

Alpha Radiation:	Is never an external radiation risk as it is stopped by a few inches of air or a single thickness of paper. However, alpha radiation may cause internal radiation hazards if NORM is inhaled or swallowed - as internal radiation hazards alpha radiation is more dangerous than gamma radiation. Alpha radiation is the least penetrating of the three radiations (alpha, beta, and gamma), but is the most dangerous as an internal hazard.
Beta Radiation:	Usually does not pose an external radiation hazard outside process equipment, as it is generally stopped by the vessel wall. Beta radiation emissions may have different energy levels depending on the isotope, with different penetrating abilities. Beta radiation can travel several feet in air but generally won't pass through ¼" of glass or plastic. However, beta radiation like alpha radiation may cause internal radiation hazards if NORM is inhaled or swallowed - as internal radiation hazards are more dangerous than gamma radiation.
External Radiation:	Radiation coming from radioactive sources outside the human body (e.g., gamma radiation from scale on oil/gas production equipment). It does not necessarily mean external to process equipment. NORM inside process equipment can act as an "external radiation" source to the human body if it is energetic enough to pass through the steel vessel or pipe wall. However, it is extremely rare to find significant gamma radiation readings outside process equipment in the oil and gas industry.
Gamma Radiation:	Is highly penetrating and is mainly a concern as external radiation. In other words, it can penetrate steel and enter the body of a person working outside equipment. Different isotopes produce gamma radiation with different energy levels, some penetrating through greater thicknesses of steel than others. However, it is extremely rare to find significant gamma radiation readings outside process equipment in the oil and gas industry.
Internal Radiation:	Radiation coming from a source inside the body. Internal radiation exposure occurs when a person breathes in or swallows NORM.
Ionizing Radiation:	High energy radiation capable of producing highly reactive chemicals inside living cells, leading to an increased risk of cell death, cancer, or birth defects (e.g., alpha, beta, gamma and X-radiation).
NORM (Naturally Occurring Radioactive Materials):	Material found in the environment that contains radioactive elements of natural origin.
Qualified Personnel:	Trained in the measurement, methods of protection, decontamination, storage and disposal of NORM.

14.0 Regulations and Guidelines

- Alberta Occupational Health and Safety Code Part 20, Section 291
- British Columbia Occupational Health and Safety Regulation Part 7, Sections 7.17 – 7.25
- Saskatchewan Radiation Health and Safety Act and The Radiation Health and Safety Regulations
- Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM) (2000)
- Transportation of Dangerous Goods Act and Regulations (2007)
- Handling Guidelines for Interim Storage of Naturally Occurring Radioactive Materials (NORM) Alberta Occupational Health and Safety

Appendix A – Revision Record

Page#	December 1, 2013	Previous Information	Risk Assessment
All	Revision of Radiation (NORM) – Technical Reference and reissuance as a Procedure.		LOW – re-issuance as a procedure that is required to be used at sites that handle NORM contaminated material.