CANADIAN ASSOCIATION
OF PETROLEUM PRODUCERS

Guide

Naturally Occurring Radioactive Material (NORM)

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The Canadian Association of Petroleum Producers (CAPP) represents 150 companies that explore for, develop and produce natural gas, natural gas liquids, crude oil, synthetic crude oil, bitumen and elemental sulphur throughout Canada. CAPP member companies produce approximately 97 per cent of Canada's natural gas and crude oil. CAPP also has 120 associate members who provide a wide range of services that support the upstream crude oil and natural gas industry. Together, these members and associate members are an important part of a $52-billion-a-year national industry that affects the livelihoods of more than half a million Canadians.

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2100, 350 – 7th Ave. S.W.
Calgary, Alberta
Canada T2P 3N9
Tel (403) 267-1100
Fax (403) 261-4622

230, 1801 Hollis Street
Halifax, Nova Scotia
Canada B3J 3N4
Tel (902) 420-9084
Fax (902) 491-2980

905, 235 Water Street
St. John's, Newfoundland
Canada A1C 1B6
Tel (709) 724-4200
Fax (709) 724-4225

Email: communication@capp.ca Website: www.capp.ca

Overview

This publication defines NORM, briefly outlines how it can occur in oilfield production, gas processing, and in the delivery and transport of propane. It further discusses health hazards and how they can be minimized through monitoring, safe work guidelines, and handling of contaminated wasters. Includes brief list of contacts and a short bibliography.

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1 Where is NORM found?

NORM is found throughout the natural environment, in man-made materials such as building materials and fertilizer and in the following crude oil and natural gas operations:

1.1 Oil and Gas Production

NORM originating in geological oil and gas formations is usually brought to the surface in produced water. As the water approaches the surface, temperature changes cause radioactive elements to precipitate. Resulting scales and sludge may collect in water separation systems. Radium is usually found in this type of NORM contamination.

1.2 Gas Processing

Radon gas brought to the surface will enter the gas production stream. As it decays, thin radioactive lead films may form on the inner surfaces of gas processing equipment. In sales gas, the radon concentrations are identical in both the inlet and outlet gas and are generally low. It has been found that the propane and LPG production process generally concentrates radon and this is where the NORM hazard potential may be the greatest.

1.3 Transport and Delivery of Propane and LPG

Propane transport equipment may be contaminated with NORM. This includes pipelines, rail cars and truck tanks. Even if the production site does not concentrate significant amounts of radon, loading contaminated transport tanks that vent into the facility may contaminate the loading facilities.

NORM is not usually present in refining operations as oil production removes NORM contaminated water before delivery to the refinery. Propane produced at refineries is usually from NORM-free crude oil so the hazard from NORM is very slight.

2 Health Hazards of NORM

Radium, radon, and their decay products are radioactive elements of concern in petroleum production and gas processing. Human exposure may occur when contaminated dusts and sludge are inhaled or ingested (internal exposure) or when gamma radiation from surrounding equipment strikes the body (external exposure). The amount of gamma radiation able to penetrate processing equipment is generally not large enough to present a health risk to employees although exceptions have been found.

Radium is found in most oil and gas fields in the world in varying concentrations. There is a potential to find radium in significant amounts in almost all types of equipment.

Radon is found in most natural gas deposits in the world. Radon is an inert, colourless and odourless gas. Radon itself does not present a health hazard because it is not easily absorbed into the body and is quickly cleared when absorbed.

Radon's radioactive breakdown products, called radon daughters, may be hazardous. Radon naturally breaks down into radioactive metals before non-radioactive lead. Radon daughters may be inhaled or ingested when attached to scale or dust generated during equipment inspection and repair. Radon daughter exposure has been associated with an increased risk of lung cancer.

2.1 Short Term Health Effects

Unprotected overexposure to excessive amounts of radium may result in skin burns. Radon and its daughters do not cause any short term health effects.

2.2 Long Term Health Effects

Unprotected overexposure to radium and radium daughter contaminated dusts has been associated with an increased risk of lung cancer and leukemia. Most NORM material taken into the body is deposited in bones where it will reside for a long time. Radium will not clear from the body significantly over time. For this reason, all exposures should be kept below recognized exposure standards for the general public and unnecessary exposure to radiation should be minimized.

Excessive radiation exposure to the fetus may increase the risk of cancer after birth. The fetus is more sensitive to radiation than an adult so a woman who is, or is planning to become pregnant should work with her employer to ensure her radiation exposure from NORM is minimized.

2.3 Occupational Exposures

Because the gamma radiation emitted by radium can penetrate vessels and pipes, its presence can be detected from the outside of process equipment. Radon is difficult to detect as only two of its decay products emit gamma rays. Both of these daughters have half-lives of less than 30 minutes, and are only detectable when facilities have been operating for at least two hours.

Previous studies show that, in most cases, worker annual exposures due to gamma radiation levels from process equipment are zero or far below legal exposure limits. In a few cases, gamma radiation has been detected in individual equipment that has the potential to expose workers in excess of the prescribed exposure limits. In these rare cases, exposures can be reduced by restricting areas or by instituting operating procedures.

Equipment contaminated with NORM may also be hazardous when opened for inspection and /or repair. Exposure may occur by inhaling or ingesting radioactive dust generated during grinding, cutting or polishing operations. Until the inhalation/ingestion hazard has been fully evaluated at the worksite, precautions must be taken.

NORM contaminated work clothing may carry NORM scale and dust home, exposing family members.

3 What you can do to protect yourself from NORM

3.1 Monitoring

Outside surfaces of equipment suspected to be NORM contaminated must be surveyed for the presence of gamma radiation. A gamma radiation instrument equipped with a properly calibrated one or two-inch sodium iodide scintillation detector and a slow/fast response switch should be used. It is important that the process equipment be running at least two hours before any gamma measurement is made.

If the dose rate at the surface is greater than two times background, the equipment may be contaminated with NORM and precautions outlined in the following Safe Work Guidelines should be followed before any inspection or maintenance work is performed. Any equipment emitting a gamma dose rate greater than 10 microsieverts/hr may be hazardous and access should be restricted until evaluated by a radiation expert.

3.2 Safe Work Guidelines

Work procedures are recommended when maintaining NORM contaminated equipment 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.

4 NORM Contaminated Wastes

Norm contaminated materials exceeding 70 Becquerels per gram (70 Bq/gm) are subject to TDG requirements.

NORM contaminated materials with activities above 0.3 Bq/gm may be a hazardous radioactive waste. A competent radiation expert must perform a risk analysis before disposal can occur. Waste containing more than 0.3 Bq/gm may be disposed in a regular fashion depending on the total amount of waste, the radioactive isotope, isotope concentrations and the disposal location. A reputable laboratory equipped with proper equipment must determine activities.

NORM contaminated wastes may include filters from contaminated process streams, storage and transport tank scale or sludge, water separation tank sludge; well bore scale and sludge from pigging operations.

Production tubing contaminated with NORM scale should be capped, labeled and stored. Tubulars should not be rattled at the rig unless you are certain they are NORM free. Other wastes should be barreled – preferably plastic to prevent corrosion – labeled and stored.

NORM storage areas should be separated from other materials and entry should be restricted. The storage area requires periodic radiation surveys to ensure gamma levels are not increasing above hazardous levels and/or site contamination is not occurring from leaking containers.

All equipment, tubular and property should be evaluated for NORM contamination before:

- Transferring to another facility.
- Equipment sale to industry, farmers, cities, schools, etc.
- Descaling.
- Reuse of equipment.
- Donating equipment to farmers, cities, schools, etc.
- Offsite repair by third parties.

5 Contacts

If you have further questions or concerns, the following individuals or agencies have an interest in the issue of NORM and may be valuable references:

5.1 Alberta

Gary Hughes
Director; Alberta Human Resources and Employment
Workplace Health and Safety
10808 – 99th Avenue
Edmonton, Alberta T5K 0G5
Phone: (780) 415- 0612

Don Burke
Waste Audit
Alberta Energy and Utilities Board
Operations Group
640-5 Ave SW
Calgary, Alberta
T2P 3G4
(403) 297-2496

5.2 Saskatchewan

Wayne Tiefenbach
Radiation Health Physicist; Saskatchewan Department of Labour
Occupational Health and Safety
Radiation Safety
1870 Albert Street
Regina, Saskatchewan S4P 3V7
Phone: (306) 787-4538 Fax: (306) 787-2208

5.3 British Columbia

David Morley; Radiation Health Scientist
Ministry of Health
Radiation Protection Services
Suite 210, 4940 Canada Way
Burnaby, British Columbia V5G 4K6
Phone: (604) 660-6629 Fax: (604) 660-6663

5.4 CAPP

Gary Webster
Manager, Environment, Health and Safety

Phone: (403) 267-1146 Fax: (403) 266-3214

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