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Chapter 2

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Naturally Occurring Radioactive Material (NORM) — A Primer

Richard M. Edmonson
Martin R. Jelliffe
Kimberly N. Holwand
Edmonson, Biggs, Mozingo & Jelliffe
Jackson, Mississippi

Synopsis

§ 2.01. Introduction.

Natural radioactivity is a fact of life. We literally live in a sea of radioactive material, and we are daily bombarded with gamma rays and alpha and beta particles of varying intensities. Naturally occurring radioactive material (NORM) is found in soil, water, plants, petroleum, phosphate, animals, and humans.

What creates a problem in the oil and gas context is that NORM is sometimes concentrated or technologically enhanced in the course of producing and processing oil and gas. The concentrated NORM may be referred to as technologically enhanced natural radioactive material (TENR). Although in the early '70s there were concerns about radioactive material associated with oil and gas operations, a series of investigations resulted in a conclusion that radioactivity was not a serious health threat;[1] thus, any concern about it dissipated until the 1980s.[2]

In the early 1980s, it was discovered that large production facilities in the North Sea were generating concentrated quantities of NORM wastes that required special management techniques. In 1986, NORM was identified in tubing in a Mississippi well by Chevron during a routine workover.[3] Chevron then notified the Mississippi State Department of Health (DOH), and as a result there was a subsequent Environmental Protection Agency (EPA) inspection of several oil field pipe cleaning

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1 Raymond H. Johnson, Jr., "Assessment of Potential Radiological Health Effects from Radon in Natural Gas," U.S. Environmental Protection Agency Report EPA-520/1-73-004 (1973).

2 Paul W. Spaite & G. Ray Smithson, "Technical and Regulatory Issues Associated with Naturally Occurring Radioactive Materials (NORM) in the Oil and Gas Industry," *Gas Research Institute*, Apr. 1992, at 1 [hereinafter cited as Spaite, "Technical and Regulatory Issues"].

3 "Bulletin on Management of Naturally Occurring Radioactive Material (NORM) in Oil and Gas Production," *American Petroleum Inst. Bull.* E2, 1st ed., Apr. 1992 at 7. A.T. Miller, E.D. Bruce & L.M. Cook, "The Management of Occupational and Environmental Exposure to Naturally Occurring Radioactive Materials (NORM)," Society of Petroleum Engineers, 22879 (1991) at 628. Chevron employees first noted the presence of Radium-containing NORM in its U.S. operations in April, 1986, when a drilling engineer noticed that some production tubing was heavily coated with a scale that was similar to the radioactive scales that he had observed in the North Sea. Gamma ray readings and later assay confirmed the presence of 226 and 228 Radium at approximately 6,000 pCi/gm specific activity. *Id.* at 628.

operations. The inspection revealed higher than expected levels of radioactivity in soil and scale samples taken from the sites.[4] This led to the filing of a lawsuit, *Street v. Chevron USA, Inc.* in the U.S. District Court for the Southern District of Mississippi, Hattiesburg Division in May, 1987, Civil Action No. H-86-0207. This case was settled after six months of trial.[5] Since the conclusion of the *Street* case, there have been a number of additional suits filed in Mississippi, Louisiana, Texas, and most recently Kentucky. NORM has also become the focus of state and federal regulatory agencies concerned about worker safety and environmental protection.

§ 2.02. NORM Radiation.[6]

The primary NORM radionuclides[7] are uranium, thorium, potassium, radium, and radon. A radionuclide is a specific type of atom which decays or transforms from one state of energy to another in a specified period of time through the process of shedding radioactive particles known as alpha and beta particles, frequently accompanied by gamma radiation.[8] The natural decay chains of uranium (U-238) and thorium (Th-232) primarily produce the radioactivity associated with oil and gas NORM waste. A "parent" nuclide will undergo successive radioactive disintegrations or decays, at each step changing into a "daughter" nuclide of a different chemical species.[9] The decay products of greatest importance are radium (Ra-226 with a half-life of 1,620 years and Ra-228 with a half-life of 6.7 years), radon (Rn-222 with a half-life of four days), and radon daughters,[10]

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4 James R. Cox, "Naturally Occurring Radioactive Materials in the Oilfield: Changing the NORM," 67 *Tul. L. Rev.* 1197, 1218 (1992).

5 *Id*. at 1217.

6 The authors do not claim any special expertise in this highly complicated field of radioactivity, and this article is intended only as a basic primer. The reader is encouraged to consult treatises written by qualified physicists for in-depth scientific facts and concepts.

7 A nuclide is any atomic nucleus. A radionuclide is a nuclide which is radioactively unstable, that is, it emits ionizing radiation.

8 William Feathergail Wilson, *N.O.R.M., a Guide to Naturally Occurring Radioactive Material,* 11-36 (1994).

9 A.L. Smith, "Radioactive-Scale Formation," *J. of Petroleum Tech.*, June 1987, at 698.

10 "Radon daughters" ordinarily refer to the short-lived Bi-214, Pb-214, Po-218, and Po-214. These nuclides can, when inhaled, irradiate lung tissue. Pb-210 and Po-210 follow