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Naturally Occurring Radioactive Material (NORM) — A Primer

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§ 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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operations. The inspection revealed higher than expected levels of radioactivity in soil and scale samples taken from the sites. 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. 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.

The primary NORM radionuclides 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. 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. 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,
principally lead (Pb-210 with a half-life of 19.4 years) and polonium (Po-210 with a half-life of 138.4 days). Radium-contaminated scale in oil wells and radon contamination in natural gas production facilities appear to be the main concern for NORM contamination.

§ 2.03. Constituents of NORM.

Radioactive elements are found in their natural state throughout the earth’s crust in varying concentrations. The highest concentrations of uranium and thorium are found in shales. The presence of uranium and thorium and their daughter products radium-226, radium-228, and radon-222 are of most concern to the petroleum industry. Although uranium is highly insoluble, radium-226 with a half-life of 1,620 years, is water and brine soluble, thus is widely disbursed via water transport. The decay of radium-226 produces radon which has a half-life of 3.8 days, but following the decay of the short-lived radon decay products is the formation of lead-210 which has a half-life of about 20 years. Radon-222 in its gaseous form is very mobile and transports radioactivity into the natural gas supply system by depositing lead-210 in vessels and transport lines. Because of their long half-lives, radium and radon daughters are susceptible to being concentrated through technological means resulting in substantial quantities of low level radioactive waste. The formation water produced with oil and gas contains various ionic species in solution including calcium and barium along with sulfate and carbonate anions. When the formation water is produced with the oil and gas, there is a change in the temperature, pressure, and pH, frequently resulting in precipitation of barium sulfate or calcium carbonate. Radium, having a chemistry similar to that of barium and calcium, will easily co-precipitate in the form of complex inorganic sulfates and carbonates.

radon daughters in the series and, with their longer half-lives, are of concern vis-à-vis pipe scale.

When radium substitutes into the barium sulfate or calcium carbonate scale, it causes the scale to become radioactive. Once formed, the barium sulfate scale is nearly impossible to dissolve.\textsuperscript{16} Mineral deposits in the form of radioactive scale and sludge can be progressively formed in production tubulars and surface processing and transportation equipment.\textsuperscript{17} The only way to remove the scale is to drill it out or otherwise physically remove it.\textsuperscript{18} As a result, NORM contamination can be found on the ground where workover operations have been conducted to remove scale, either at the well site or at a remote pipe cleaning yard.\textsuperscript{19} NORM-contaminated scale and sludge is also found in production equipment, such as wellheads, heater treaters, and storage tanks, as well as the pipe connecting the equipment.

\textbf{§ 2.04. NORM Radiation Units.}

Radiation units are confusing, sometimes imprecise, and in a state of flux.\textsuperscript{20} In measuring radiation two concepts are important: exposure and dose.

Exposure measures the radiation to which an object is subjected, and is defined as “the product of radiation flux density multiplied by exposure

\begin{itemize}
  \item \textsuperscript{17} Marinello, “Understanding the Basics,” at 6-7.
  \item \textsuperscript{18} Oddo, “NORM Scale Formation,” at 92.
\end{itemize}

It would appear that radiation units have been designed by scientists to mollify, obviate, and generally create a fog of confusion for their fellow scientists and the public at large. This conspiracy was developed to conceal the fact that scientists do not want their colleagues to know that they don’t know much about radiation. The reason they don’t know much about radiation is that all good scientists watched the late night movies on television and discovered that Marie Curie was maimed and died of an overdose of radiation. These young, impressionable scientists thought twice about the hazards of radiation research, so they devised a clever curtain of conspiracy laced with confounding nomenclature. This may
Dose is a measure of the radiation that actually interacts with matter and has been defined as “the radiation energy delivered to a specified area or volume or to the whole body. In radiology, the dose may be specified in air, on the skin, or at some depth beneath the surface; no statement of dose is complete without a specification of location.” A third category, or perhaps a subcategory of dose, is the measure of the biological effects of the exposure.

The most basic unit of radiation is the curie which measures the quantity of the radioactive material in nuclear disintegrations per second. One curie equals $3.7 \times 10^{10}$ disintegrations per second or 2.2 trillion disintegrations per minute. The activity of radioactive material found in most oil and gas productions is considerably smaller than a curie and is, therefore, measured in picocuries (1 picocurie equals one-trillionth of a curie). A determination of the concentration of radiation in any material requires a laboratory analysis and is usually expressed in picocuries per gram (pCi/g) of solid material and picocuries per liter (pCi/l) of air and water.

A roentgen is a unit of exposure defined as that amount of x-ray or gamma radiation which will produce one electrostatic unit of charge in one cm$^3$ of dry air at standard conditions. More simply, it is the unit of measurement expressed as a rate (i.e., per unit time) commonly used on most field measuring instruments, such as a calibrated scintillation detector to measure the gamma rays being emitted by the radioactive material. Typically, a well site is surveyed using a gamma scintillation detector to determine preliminarily if the equipment and/or soil have excessive levels of gamma radiation. Readings are usually taken in microroentgens per hour (\(_\text{R}/\text{h}\)). A \(_\text{R}\) is $1 \times 10^{-6}$ roentgens or 0.000001 roentgens.

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22 Id. at 39.
23 Id. at 8.
24 Id. at 13.
25 Id. at 13-15.
Background measurements for gamma radiation on the earth’s surface generally range from 4 \( _{\text{R}}/\text{h} \) to 12 \( _{\text{R}}/\text{h} \).\(^{26}\)

Although there is a relationship between the activity concentration (picocuries per gram) and gamma ray emissions (microroentgens per hour), the precise concentration of NORM in the scale cannot be accurately predicted from the external gamma measurements.\(^{27}\)

Radiation dose, that is, the amount of energy deposited in the body tissue from ionizing radiation, is measured in rad. Rad means “radiation absorbed dose.” A rad is an expression of the quantity of energy absorbed in a specific matter by any type of radiation, alpha, beta, or gamma.\(^{28}\)

Since some types of radiation have different biological effects for a given amount of energy absorbed, the concept of dose equivalent measured in rem (roentgen equivalent man) was devised. It is calculated by multiplying the dose (in rads) by a quality factor which takes into account the type of radiation causing the dose.\(^{29}\) The quality factor for gamma and beta radiation is one. The quality factor for alpha radiation is 20. Thus, when gamma or beta radiation is being measured, one roentgen equals one rad equals one rem.\(^{30}\) The average U.S. citizen receives 100 to 800 millirems per year from natural background sources of radiation.\(^{31}\)

§ 2.05. Health Effects of NORM.

Radiation causes harm to human tissue through a process known as ionization. Ionization occurs when the alpha or beta particles or the gamma rays interact with the electron cloud surrounding the atoms in the irradiated medium causing an orbital electron to be removed leaving an unbalanced positive charge on the atom.

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\(^{28}\) Id.

\(^{29}\) Id.

\(^{30}\) Oddo, “NORM Scale Formation,” at 34.

\(^{31}\) Id.
Ionization is the mechanism by which radiation causes biological effects in tissue. The tissue structural alteration can be caused directly by the ionization or indirectly through chemical reactions initiated by the ionizing event. The degree of damage caused by radiation will vary depending upon the susceptibility of the tissue, which part of the cell is damaged and the time in the cell life the damage occurs. Once ionization occurs in the cell, the cell may die, it may divide and produce abnormal daughter cells, or it may repair itself.\textsuperscript{32}

A significantly large dose of radiation can cause serious harm, even death, within days or weeks.\textsuperscript{33} Exposure of up to 100 rems\textsuperscript{34} of acute ionizing radiation is considered subclinical with no immediate or long-range consequences. Acute exposure in excess of 100 rems has serious health consequences.\textsuperscript{35}

The health effects of low levels of radiation is not well understood and is the subject of debate, particularly whether there is a “threshold” below which there should be little concern for regulations.\textsuperscript{36} The studies on carcinogenic effects of radiation have come from animal studies or from follow-up of the A-bomb survivors. The Beir V Report could not find conclusive or consistent evidence of an increased incidence of cancer associated with populations associated with chronic exposure to low level

\textsuperscript{32} See generally, Beir V.
\textsuperscript{34} “An average individual in the U.S. receives an annual full body dose of approximately 300-500 mrem from natural sources of radiation, which is described as ‘background.’” \textit{Id.} at 96. See \textit{supra}, n.46 wherein Oddo uses the figures 100-800 mrem dose per year.

“Since most gas and oil field NORM is composed of 226\textsubscript{Ra} coprecipitated in scale, 2000 pCi/g of soil or scale has approximately two one-billionths of a gram of Radium included. Whether these levels of radiation are harmful is beyond the scope of this article and is the subject of current debate.” John E. Oddo, “Algorithms Can Predict: Inhibitors Can Control NORM Scale,” \textit{Oil & Gas Journal}, January 3, 1994, at 34.
radiation. However, it is accepted that the human effects of ionizing radiation increases in rough proportion to the cumulative dose received during a lifetime, and most regulators and plaintiff’s attorneys maintain there is no threshold limit below which there is no adverse effect. The concept that there is no completely risk free level of exposure (linear dose effect theory) has support in the scientific literature and in the regulations. The report was prepared through the joint effort of NRC, OSHA, DOE, NASA, EPA, DOT, the Mine Safety and Health

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37 Beir V at 5-6. “While experiments with laboratory animals indicate that carcinogenic effectiveness per Gy [one Gray = 100 rads] of low-LET [linear energy transfer] radiation is generally reduced at low doses and low dose rates, epidemiological data on the carcinogenic effect of low-LET radiation are restricted largely to the effects of exposures at high dose rates. Continued research is needed, therefore, to quantify the extent to which the carcinogenic effectiveness of low-LET radiation may be reduced by fractionation or protraction of exposure.” Id. at 7. The Beir V report goes on to conclude, however, that while recent studies show that damaged cells can repair themselves, “... the new data do not contradict the hypothesis, at least with respect to cancer induction and hereditary genetic effects, that the frequency of such effects increases with low level radiation as a linear, nonthreshold function of dose.” Id. at 4.


40 See generally, John W. Gofman, Radiation and Human Health, 22-30 (1981). Recent scientific literature questions the basis of some of the linear theory concepts. But see, e.g., R. G. Thomas, “The US radium luminisers: A case for a policy of ‘below regulatory concern,’” J. of Radiation Protection 1994, Vol. XIV. Thomas states that: “Linear extrapolation is an ideal approach for avoiding the obvious lack of effect at low doses, it involves simple mathematics, and it is an appealing way to derive risk coefficient for setting radiation standards.” Id. at 142. Thomas further states:

To extrapolate, particularly with linearity, is easy, but perhaps it is time to think about the socioeconomic consequences of incorrectly making radiation appear to be a highly toxic insult. Perhaps it is time to let the data direct the conclusions instead of formatting the extrapolation scheme beforehand and forcing the data to fit the preconceived pattern. It may be time to reevaluate (again) the background radiation level variations throughout the world and to stop being concerned with and regulating against miniscule doses for which no tumorigenic effects on humans have been satisfactorily identified or quantified (e.g. <1 cGy). Id. at 151.

Administration, the Department of Defense, the Department of Commerce, and the Department of Health & Human Services. According to the report: “Based upon extensive but incomplete scientific evidence, it is prudent to assume that at low levels of exposure, the risk of incurring either cancer or hereditary effects is linearly related to dose received in the relevant tissue. The severity of any such effect is not related to the amount of dose received. That is, once a cancer or an hereditary effect has been induced, its severity is independent of the dose. Thus, for these two types of effects, it is assumed that there is no completely risk free level of exposure.”

§ 2.06. Regulatory Efforts.

Regulatory environmental agencies are charged with determining the acceptable levels of human exposure to hazardous materials. This is done through a process of risk assessment. Ideally, the risk characterization is determined through scientific methods by scientists which in turn allows the regulators to determine risk management, that is, setting site cleanup levels and acceptable exposure levels. This marriage between the scientific community and the regulators has been a tenuous one, drawing criticism from both sides. One particularly harsh critic called for changes to make the process more scientific saying that the status of risk assessment is a “shotgun wedding between science and the law.”

42 Id. at 2824.
44 Id. at 258. See also, R. G. Thomas, “The US Radium Luminisers: a Case for a Policy of ‘Below Regulatory Concern,’” J. of Radiation Protection 1994, Vol. XIV, at 151 (1994). After reciting a position taken by EPA concerning its proposed drinking water standards for radionuclides including radium, Thomas states: “This excerpt exemplifies how the need to satisfy certain ground rules (the use of linear modeling with what the EPA referred to as dose-squared radium dial painter data) forces the rulemakers to use only data that tend to give the desired result, or to use dicta for the interpretation of scientific data. One can only marvel that such results are generally acceptable by the standard-setting community.” Id. at 151.
The regulators recognized that persons are necessarily exposed to some degree to ionizing radiation in excess of the exposure due to natural radiation, and it involves some risk. The job of the regulator then is to make the risk so small that it is not unacceptable to the individual and the public at large, that is, to make the risk “as low as reasonably achievable” — acronym ALARA — a concept which has been superimposed into most regulatory schemes. Because of a conservative risk assessment approach by the regulators and because the concept of ALARA has become so ingrained in the existing regulations, it may be optimistic to expect less stringent standards to be promulgated for similar materials despite differences in circumstance.

It is indeed a formidable task to wade into the sea of hazardous waste and radiation regulations, both state and federal. There is a problem of overlapping federal regulations, and a lack of agreement over levels of

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46 Beir V reports that natural radiation contributes 82 percent of the average annual effective dose equivalent to a member of the U.S. population. Eighteen percent comes from manmade radiation, such as x-rays and nuclear fallout. The total average annual effective dose equivalent is 360 millirems per year (mrem/yr) or 360,000 microrems per year. Beir V at 18-19. Estimated average annual dose rate from background in the U.S. is .2 rem or 200,000 microrems. A smoker averaging 1.5 packs of cigarettes per day receives an estimated exposure of 8.0 rem/yr. or 8,000,000 microrems. Marinello, “Understanding the Basics” at 9.

47 ALARA is defined at 10 C.F.R. § 20.1003 as follows:

. . . making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.


50 “It was stated in 54 A.D. by that great Roman philosopher, Gluteus Maximus, that ‘keeping up with regulations was akin to nailing Jell-O to a tree.’ Gluteus went on to state that regulations inspired an inverse relationship with respect to comprehension.” William Feathergail Wilson, N.O.R.M., a Guide to Naturally Occurring Radioactive Material, 123 (1994).

51 Id. at 129-30.
exposure, the threshold level, and even units of measurement. The Atomic Energy Act was enacted to govern radioactive material, and it granted authority to the Nuclear Regulatory Commission to regulate certain radiation substances. However, NORM is not subject to NRC regulations since NORM does not fall within the definition of source, special nuclear material or by-product material. While NRC regulations do not directly apply to NORM, much of the nomenclature, definitions, and dose limits contained in the NRC regulations have been adopted by NORM regulators. For example, a licensee under the NRC regulations is required to control the occupational dose of an adult to an annual total effective dose equivalent (TEDE) of 5 rems (5,000 mrems). The same TEDE is contained in the

52 Id. at 125.
55 Source is defined at 10 C.F.R. § 20.1003 as “(1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or (2) ores that contain, by weight, one-twentieth of 1 percent (0.05 percent), or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material.”
56 Special nuclear material is defined at 10 C.F.R. § 20.1003 as: “(1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the Commission, pursuant to the provisions of § 51 of the Act, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing but does not include source material.”
57 By-product material is defined at 10 C.F.R. § 20.1003 as “(1) any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or utilizing special nuclear material; and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discreet surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute ‘by-product material’ within this definition.”
59 See Regulations for Control of Radiation in Mississippi, Division of Radiological Health Bureau of Environmental Health State Department of Health, § 801.D.3
Mississippi NORM Regulations. Thus, the NORM practitioner should be familiar with NRC regulations.

§ 2.07. NORM Regulations.

Almost by default the states have taken the lead in regulating NORM waste. According to a report issued by the Interstate Oil and Gas Compact Commission, there are four states which have enacted NORM regulations (Arkansas, Louisiana, Mississippi, and Texas). Six other states currently have or are working on drafts of proposed regulations: Alabama, Colorado, Illinois, Michigan, New Mexico, and Oklahoma. Kentucky has identified NORM in the Martha Oil Field, but is delaying the promulgation of NORM regulations. The EPA is threatening to get into the act and is in the process of implementing proposed regulations for radiation site cleanup.

In 1974 the Conference of Radiation Control Program Directors (CRCPD), made up of personnel from state radiation control programs, based on authority derived from the NRC, established a task force to work on suggested model NORM regulations. That group has promulgated several editions of the “Suggested State Regulations for Control of Radiation,” the most recent draft involving a proposed model regulation for NORM dated June 1994. CRCPD’s work on Part N has been used incorporated into the NORM Regulations by reference through § 801.N.11 [hereinafter cited as “Miss. Regs”].


64 Part N, Regulation and Licensing of Naturally Occurring Radioactive Materials (NORM), June 1994, published by the Conference of Radiation Control Program Directors, Inc. CRCPD is in the process of revising its prior proposed Part N Regulations set forth in an April 1991 draft and has already submitted the June 1994 draft for industry
by several states to promulgate regulations governing NORM waste.\textsuperscript{65} The Louisiana NORM regulations\textsuperscript{66} and the Mississippi NORM regulations\textsuperscript{67} are quite similar. They both appear to have been patterned after the model act, and either can serve as an example of regulatory requirements governing NORM.

NORM is defined in the Mississippi Regulations as “any nuclide which is radioactive in its natural physical state (i.e., not man-made), but does not include by-product, source, or special nuclear material.”\textsuperscript{68} Anyone mining, extracting, receiving, possessing, owning, using, processing, or transferring NORM in excess of the specified contamination limits without regard to quantity, becomes a licensee, and subject to all of the requirements of the regulations.\textsuperscript{69} The regulatory limits in Mississippi to be exempt from the requirements of Section N are: (1) in material (soil), concentrations of less than five picocuries per gram of Ra-226 or Ra-228 above background or 30 picocuries per gram averaged over any 100 square meters; and (2) in equipment, radiation levels not in excess of 25 microroentgens per hour above background.\textsuperscript{70} Produced waters are exempt provided the produced waters are re-injected into an approved disposal well.\textsuperscript{71}

A licensee is prohibited from: (1) transferring for unrestricted use any equipment which has radiation levels exceeding 25 microroentgens per hour above background;\textsuperscript{72} (2) transferring for unrestricted use land

\textsuperscript{65} Spaite, "Technical and Regulatory Issues" at 7-12.

\textsuperscript{66} 33 La. Adm. Code, § 15:1401, et seq.

\textsuperscript{67} Miss. Regs., § 801.N.

\textsuperscript{68} Miss. Regs. § 801.N.3. Thus, by definition the NORM regulations exclude radioactive material regulated by NRC under 10 C.F.R. § 20.1002.

\textsuperscript{69} Miss. Regs. § 801.N.10(a). [The Miss. Regs. consist of 14 sections, including Section N.]

\textsuperscript{70} Miss. Regs. § 801.N.4(a).

\textsuperscript{71} Miss. Regs. § 801.N.4(f).

\textsuperscript{72} Miss. Regs. § 801.N.10(b).
contaminated with radium in excess of 30 picocuries per gram (where radon emanation rate is less than 20 picocuries per square meter per second), or (where radon emanation rate is 20 picocuries per square meter per second or more) 5 picocuries per gram averaged over the first 15 centimeters of soil below the surface and 15 picocuries per gram averaged over 15-centimeter thick layers of soil more than 15 centimeters below the surface.\textsuperscript{73}

Among the things a licensee is required to do are: (1) post with conspicuous signs radiation areas, high radiation areas, and very high radiation areas, as those terms are defined;\textsuperscript{74} (2) develop, document and implement a radiation protection plan;\textsuperscript{75} (3) control the annual occupational dose to individual adults not to exceed five rems;\textsuperscript{76} (4) conduct operations so that the total effective dose equivalent (TEDE) to individual members of the public does not exceed 0.1 rem per year;\textsuperscript{77} (5) make surveys necessary to evaluate radiation levels and concentrations of radioactive materials\textsuperscript{78} and maintain records of those surveys;\textsuperscript{79} (6) manage and dispose of NORM-contaminated waste (a) in accordance with the requirements of the EPA; (b) in a manner equivalent to the requirements for uranium and thorium by-product materials in 40 C.F.R. 192; (c) by disposing of the waste in an appropriately licensed land disposal facility; or (d) in accordance with alternative methods where so authorized by the Mississippi Department of Health.\textsuperscript{80}

By legislative enactment effective July 1, 1995, the Mississippi legislature has transferred to the Mississippi Oil & Gas Board the authority to make rules, regulations, standards, and orders to regulate the use, management, manufacture, production, ownership, and disposal of oil field exploration and production wastes. By definition “oil field exploration

\textsuperscript{73} Miss. Regs. § 801.N.10(c).
\textsuperscript{74} Miss. Regs. § 801.D.902.
\textsuperscript{75} Miss. Regs. § 801.D.101.
\textsuperscript{76} Miss. Regs. § 801.D.201(a).
\textsuperscript{77} Miss. Regs. § 801.D.301(a).
\textsuperscript{78} Miss. Regs. § 801.D.501.
\textsuperscript{79} Miss. Regs. § 801.D.1103.
\textsuperscript{80} Miss. Regs. § 801.N.12(a).
§ 2.08 Waste Cleanup and Disposal.

Waste cleanup and disposal is the most pressing NORM problem currently facing the oil and gas industry even though significant concentrations of NORM have been found in only a small percentage of oil and gas production operations. It does not take much contamination to exceed the very low regulatory limits. In Mississippi and Louisiana, a cleanup can be triggered by a concentration of five picocuries per gram of radium-226 in the soil. This is $5 \times 10^{-12}$ curies, an incredibly small number. Equipment with gamma ray readings in excess of $25 \ _\text{R/h} (25 \times 10^{-6})$ cannot be released for unrestricted use and can only be decontaminated on site or at a pipe cleaning yard by persons specifically licensed to do so.

Radium-contaminated scale is the primary NORM contaminant because of its high volume, highly concentrated form, long half-life and pervasiveness due to pipe cleaning operations. The extent, and therefore the cost, of a cleanup can only be determined after a site characterization has been performed. The site characterization, preferably performed under the direction of a qualified health physicist, is begun by first surveying the surface with an appropriate radiation detection instrument. If the gamma ray readings are sufficiently high (typically twice background), the second phase of the site characterization is to determine the radium concentration in picocuries per gram in the soil. There are specific protocols in performing this test, and the result is a determination of the extent of contamination in the soil, both in area and depth. The concentration of radiation in the soil must be determined by laboratory tests from soil samples taken at the site. The result of this test will determine the amount

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81 House Bill No. 1391.
83 The distance from the sun to the edge of the planetary system is $5.9 \times 10^{12}$ meters.
of soil that must be removed in order to get the site contamination to less than the regulatory limits or as low as reasonably achievable (ALARA).

A site characterization can be very expensive, depending on the size of the site and the number of soil samples taken. However, the biggest expense and most perplexing problem is what to do with the contaminated material once the site has been remediated. There are three possible alternatives: (1) consolidate and store on company-owned property; (2) send it to a licensed radioactive waste facility; or (3) in accordance with alternative methods authorized by the regulatory agency. The first alternative (storing on company property) is at best a temporary solution for the producer, but for the short term, it is the least expensive.

The second alternative, sending to a licensed radioactive waste facility, presently appears to be a long-term solution, although locating a storage facility can be a problem, and in some instances, it could be prohibitively expensive. In 1991 there were only four licensed facilities in the U.S., “one which can’t take radium, one which only accepts Department of Energy waste, and one is reported to be about full.”

The third alternative, management methods approved by the appropriate regulatory agencies, could include downhole disposal or some type of land farming treatment. Produced water is already routinely disposed of in approved disposal wells. The Mississippi Oil & Gas Board

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86 There are licensed radioactive waste facilities located in South Carolina, Nevada, Washington, and Utah.
87 Costs of packaging, handling, transportation, and storage can vary and has been estimated to be $500 to $1000 per drum for material generated on the Gulf Coast and disposed of in Utah. Spaite, “Technical and Regulatory Issues” at 25. Dr. Peter Gray estimates cost of storage in a Texas low level repository will be $175 per cubic foot. P.R. Gray, “NORM Contamination in the Petroleum Industry,” Society for Petroleum Engineers, 22880 (1993) at 15.
has recently approved downhole disposal of contaminated soil, and while it has not yet been widely utilized, it may be the best long-term solution to the disposal problem.

§ 2.09. Potential Liability Under CERCLA.

Currently the primary area of concern for NORM contamination at the federal level is the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), which is a potential source of liability for both past and present oil and gas operators of well sites containing NORM. The intent in enacting CERCLA was to provide a means for the remediation of old and abandoned hazardous substance sites so that they no longer pose a threat to health and public safety. Primarily this would be the responsibility of the Environmental Protection Agency (EPA). The EPA can perform the remediation and then seek reimbursement of those remediation costs from those parties who meet the statutory criteria of liability. However, the EPA is not the only entity that has the right to remediate and seek response costs from liable parties. CERCLA makes it clear that private parties also have that right.

It is well established that a party can state a prima facie case of liability under CERCLA if he proves the following:

1. the site is a “facility” as defined in Section 9601(9);
2. the defendant is a responsible person as defined in Section 9607(a);
3. a release or threatened release of a hazardous substance has occurred; and
4. plaintiff has incurred response costs as a result.

Therefore, it follows that if NORM constitutes a hazardous substance under CERCLA and costs are incurred in responding to or cleaning up

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89 Mississippi Oil and Gas Board Rule 68, effective September 9, 1994, allows for NORM material to be encapsulated between cement plugs or made into a slurry and placed in the formation.
92 Id.
95 Amoco Oil Co. v. Borden, Inc., 889 F.2d. 664, 668 (5th Cir. 1989).
the NORM, whether those costs are incurred by either the EPA or a private party such as a surface owner, then suit can be filed against any liable party under CERCLA to recover those costs.

[1] — NORM as a Hazardous Substance.
There is authority which supports the proposition that radionuclides such as radium-226 and radium-228 commonly found in NORM, and, therefore, NORM itself, are considered as hazardous substances under CERCLA. Moreover, since there is no statutory threshold in terms of quantity before such radionuclides will be considered as hazardous substances under CERCLA, the presence of any level of NORM on a well site will come within the CERCLA definition of hazardous substances.

CERCLA sets forth four categories of parties who will be liable for the recovery of costs incurred in responding to or cleaning up hazardous substances from a site. At least two of these categories could apply to oil and gas operators: (1) present owners and/or operators of a hazardous substance site; and (2) past owners or operators if they owned or operated the site at the time the hazardous substances were disposed of at the site.

What this means in terms of oil and gas operators is clear. If you currently own or operate a well site which is contaminated with NORM, or if you owned or operated a well site at a time when NORM was deposited on the site, then you are a potentially responsible party. Furthermore, unlike the common law theories of liability where some degree of fault or proximate cause is required, liability under CERCLA does not depend on fault. A party merely needs to fit into one of the statutory categories. It should also be emphasized that liability under

96 Id. at 668-669. 42 U.S.C. 9601 (14) identification and listing 40 C.F.R. 302-1 RQ listings for reporting. Do these suggest a test for threshold? Even if subjective?
97 Id.
CERCLA is joint and several, \(^{101}\) although any person may seek contribution from any other person who is liable or potentially liable. \(^{102}\)

### [3] — **Response Costs Under CERCLA.**

Although there is no quantitative threshold under CERCLA for determining what is a hazardous substance, case law has held that there is such a threshold for determining whether a release of a hazardous substance has caused the incurrence of response costs. \(^{103}\) The Court in *Amoco* recognized the absurdity of arguing that the release of any quantity of a hazardous substance would create CERCLA liability. To allow otherwise would cause CERCLA to exceed its statutory purposes by holding parties liable who posed no threat to the public or the environment. \(^{104}\) Consequently, this Court held that “a plaintiff who has incurred response costs meets the liability requirement as a matter of law if it is shown that any release violates, or any threatened release is likely to violate, any applicable state or federal standard, including the most stringent.” \(^{105}\)

This means that a surface owner cannot simply go out and clean up NORM, no matter how small the quantity, and then file a claim under CERCLA seeking recovery of those response costs. Instead, there must first be a release of NORM in quantities which are in excess of applicable regulatory standards. However, if there is such a release, a CERCLA claim for response costs would certainly be possible. Moreover, some response costs which would be allowable under CERCLA are not necessarily recoverable as damages under common law theories of liability. A landowner essentially has a two-prong approach for the recovery of damages. One would be a tort claim under the applicable state common law theories of recovery. This could include the alleged damage to real property in terms of diminution of value or costs of remediation, as well as any other damages allowed by state law. It would also include any

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\(^{103}\) Amoco Oil Co. v. Borden, Inc., 889 F.2d. 664, 669-670 (5th Cir. 1989).

\(^{104}\) *Id.* at 670.

\(^{105}\) *Id.* at 670.
personal injury claims. The other would be a CERCLA cause of action for response costs not otherwise recoverable under common law.

Among the types of response costs deemed recoverable under CERCLA by some courts are: costs incurred in testing,\textsuperscript{106} costs incurred in monitoring and evaluating the extent of the contamination,\textsuperscript{107} on-site soil testing, water monitoring, and medical testing and screening in order to assess the effect of a release of a hazardous substance,\textsuperscript{108} litigation expenses, excluding attorney’s fees,\textsuperscript{109} and erecting a fence around a contaminated area, employing a guard service to secure the site from trespassers and the posting of bilingual “no trespassing” signs.\textsuperscript{110}

Not all of the courts that have looked at the issues regarding what is and what is not an appropriate response cost are in agreement. Other courts have not specifically addressed these issues. Nevertheless, the point that should be emphasized is that a potentially responsible party under CERCLA should not find comfort in the EPA’s apparent lack of concern over NORM in the oilfield. That lack of concern could be changing now that the EPA is in the process of proposing rules regarding NORM. Moreover, because of CERCLA’s private right of action to recover response costs, any current or past owner or operator of an oil well site on which NORM can be found in quantities which are in excess of regulatory limits needs to be concerned. Not only could such an owner or operator be sued for damages in tort under state common law theories of recovery, but also for response costs under CERCLA.

§ 2.10. Litigating NORM Cases.

Although NORM is a relatively new litigation subject, the theories of recovery pursued in the NORM litigation to date have been tort theories.

\textsuperscript{106} Wickland Oil Terminals v. ASARCO, Inc., 792 F.2d 887 (9th Cir. 1986).
\textsuperscript{107} Artesian Water Co. v. Gov’t of New Castle County, 851 F.2d 643 (3d Cir. 1988).
\textsuperscript{109} Louisiana-Pacific Corp. v. ASARCO, Inc., 6 F.3d 1332 (9th Cir. 1993).
\textsuperscript{110} Cadillac Fairview/California, Inc. v. Dow Chemical Co., 840 F.2d 691 (9th Cir. 1988).
Plaintiffs also allege strict liability in tort based upon the assertion that defendants are conducting an abnormally dangerous or ultrahazardous activity. Therefore, it is important that the practitioner review the common law of his or her jurisdiction to determine if that jurisdiction has defined what activities constitute ultrahazardous activities, or if the jurisdiction has adopted Section 402 of the *Restatement Second of Torts*.

Plaintiffs also pursue trespass to land theories on much the same basis as the nuisance claims, that is, that defendants have allegedly caused NORM to enter and contaminate the soil and/or ground water on plaintiffs’ property without plaintiffs’ consent, and that defendants’ continued entries on the plaintiffs’ land for the purpose of installing equipment and production facilities which allegedly emit NORM constitute a continuing trespass.

Plaintiffs also allege that defendants, in contaminating the plaintiffs’ property with NORM, exceeded the scope of activity authorized by the lease agreement between plaintiffs and the defendant operators so as to give rise to a breach of contract or waste argument.

To date there have been basically two types of NORM suits: (1) those where significant personal injuries are alleged, and (2) those which are basically damage to real property cases. The personal injury suits have been brought by employees of oilfield pipe cleaning facilities who allegedly have much greater radiation exposure due to their coming in contact with a large quantity of radioactive scale as they beat the scale from the pipe. One such case was *Street v. Chevron*,\(^{112}\) which was tried in the Southern District of Mississippi for six months but settled during trial. Although there are other pipe cleaning facility cases filed, they have yet to come to trial.

The majority of NORM cases focus predominantly on damage to real property relying on the common law property torts discussed above. However, typically these cases also contain allegations of infliction of emotional distress and assault and battery of plaintiffs’ bodies from radioactive particles or rays.

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\(^{111}\) For example, see Miss. Code Ann. § 17-17-17 (1972).

A major issue in NORM litigation is the extent of NORM contamination, if any, to the plaintiffs’ property and what damages plaintiffs are entitled to recover as a result of that alleged contamination. As a matter of course, plaintiffs in their complaints seek property damages which include the costs of site characterization, monitoring, and remediation, as well as loss of property value and accompanying stigmatic losses. As the initial testing and, if needed, subsequent remedial procedures in these cases can be extremely costly, this is a very important issue.

Additionally, plaintiffs seek compensation for their personal injuries — sometimes described as “damages for disruption of bodily tissues and cells resulting from exposure to ionizing radiation” as well as the more common claims for anxiety, distress, fear, aggravation, and inconvenience.

Some plaintiffs have also sought declaratory and injunctive relief in their complaints and asked the court to declare the defendants liable for the costs of site investigation, monitoring and remediation of the alleged NORM, as well as injunctions requiring complete site investigation and remediation upon prior notice to plaintiffs and in accordance with methods and procedures that meet with the plaintiffs’ approval. No such declaratory or injunctive relief has been granted in a NORM case thus far.

The following are the primary defenses asserted by defendant oil producers and service companies in NORM cases:

a. Defendants made reasonable use of the surface of the land in order to avoid waste and reasonably develop the minerals thereunder;

b. Any oil field materials to which plaintiffs were allegedly exposed and which are allegedly on plaintiffs’ property were not hazardous to health. In the alternative, if it is established that the materials were hazardous to health, defendants did not know or have reason to know of such hazard;

c. The actions of the defendants are not the proximate cause of any damages complained of by plaintiffs; and

d. Defendants are not strictly liable to plaintiffs because their operations or any material produced therefrom are not abnormally dangerous or ultrahazardous.


The foremost defense in any NORM case is that the operator used the leased premises in a way reasonably necessary to produce the lease without violating the reasonably prudent operator standard. This defense is based upon the common law of a majority of jurisdictions that:

An oil and gas lease carries with it the right to possession of the surface to the extent reasonably necessary to enable a lessee to perform the obligations imposed upon him by the lease. In short, the holder of a valid oil and gas lease has the right to go on the land and do all things necessary and incidental to the drilling of a well, including the right to use the surface . . . .

The Mississippi Supreme Court in describing the rights of an oil and gas lessee has stated that “a grant or reservation of mines or minerals gives to the mineral owner the incidental right of entering, occupying, and making such use of the surface lands as is reasonably necessary in exploring, mining, removing, and marketing the minerals.” The corollary of this rule, which is also ascribed to by a majority of jurisdictions, is that an oil and gas lessee is not liable to a surface owner, absent a specific lease provision otherwise, for surface damage resulting from reasonable and necessary production activity.

Thus, if the NORM complained of in a particular suit is located within the perimeter of the well site, the operator should be able to successfully argue that under the common law it has no duty to remediate or compensate surface owners for NORM contamination as the NORM was generated by reasonable and necessary production within the area reasonably required for proper oil or gas drilling.

113 Summers Oil & Gas § 652.
114 Gulf Refining Co. v. Davis, 80 So. 2d 467 (Miss. 1955).
115 See Cities Service Oil Co. v. Corley, 197 So. 2d 244 (Miss. 1967); Placid Oil Co. v. Byrd, 217 So. 2d 17 (Miss. 1969); Sun Oil Co. v. Nunnery, 170 So. 2d 24 (Miss. 1964). (State NORM regulations which require the producer to clean up the well site prior to its being released for unrestricted use obviously supersede the common law on this point.)
116 See Central Oil Co. v. Shows, 149 So. 2d 306 (Miss. 1963).
In *Central Oil Co. v. Shows*, the Mississippi Supreme Court specifically discussed damages to the well location. There, the defendant oil lessee built a gravel road to the site, leveled the ground for a turnaround, dug two pits in the ground, one of which was a slush pit, dumped several loads of gravel upon the road and the well site and breached several terrace rows in the construction of the road. After its drilling operation was over, the lessee had a fence replaced, the road smoothed out, and one of the pits refilled with soil. However, the terrace rows were not rebuilt, and the slush pit was not refilled. The slush pit contained caustic soda and liquid refuse used in drilling the oil well. The pit later broke allegedly causing surface damage. In describing the nature of the suit, the court stated that there was no charge or proof that the defendant had used more land than was reasonably necessary for its drilling operations, nor was there unreasonable use or destruction of timber, crops, fences, ponds, and structures located outside the area actually necessary for drilling operation. Rather, “the suit, is an action for the negligent use of the soil surface within the perimeter of the land space reasonably required for proper oil drilling. . . .” The court stated that the plaintiff had no cause of action against the lessee for the use of the land reasonably necessary for the purpose of drilling oil. The court explicitly stated:

In exercising its right to obtain the minerals, appellant was not liable to appellee-land owner for failing to rebuild a terrace row smoothed out during its drilling operation, nor for damages caused to the surface of the land as a result of leaving the gravel and mud mixed with the top soil, *within the perimeter of the area shown to have been reasonably necessary for its operation*. We are also of the opinion that appellant had the right to dig pits and erect dams within the area reasonably necessary to conduct its drilling operations.

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117 *Id.*
118 *Id.* at 309.
119 *Id.* at 310.
120 *Id.* at 310 (emphasis added).
The court also held that the owner of the minerals was not required to refill the slush pit which was necessarily constructed during the drilling operation.\textsuperscript{121} Rather, the court stated that the lessee’s liability was only for damages that were caused as a result of leaving the pit open and it having spilled out and damaged trees outside of the area reasonably necessary for the production of the oil. The court concluded its opinion with the statement that “there was no evidence introduced to show that it [appellant] was negligent in the use of the property within the perimeter of the oil well site.”\textsuperscript{122} Therefore, there is strong precedent that surface owners are not entitled to recover damages to the land within the perimeter of the oil well site unless they can prove negligence on the part of the operator. How this squares with the operator’s duties as a licensee under the NORM regulations has not yet been decided. However, it would seem clear that as long as there are continued oil and gas operations at the well site or the well sites are being held for future use (that is, not yet plugged and abandoned), any suit for remediation under NORM regulations would be premature.

[b] — Negligence.

The negligence analysis in NORM cases is the same as in other negligence cases, namely what duty was owed by the defendant given what he knew or reasonably should have known about NORM, whether that duty was breached and whether the plaintiff was injured as a proximate result. These elements will be established by the testimony of the corporate representative as to the defendant’s knowledge of NORM, and the testimony of experts as to whether the plaintiff was injured as a proximate result of any alleged exposure to NORM. Issues of fact which bear on the question of negligence are: the extent of contamination on the property, when the property became contaminated, the identity of the party who caused the contamination, and whether the contamination could have been prevented.

\textsuperscript{121} \textit{Id.} at 311.
\textsuperscript{122} \textit{Id.} at 311.
[c] — Trespass and Nuisance.

Defendants argue that they are not guilty of trespassing upon plaintiffs’ property as they were present upon the surface owners’ land pursuant to a valid oil and gas lease. Of course, plaintiffs also allege that the radiation itself constitutes a trespass for which the defendant operators are liable. Although this particular issue has never been addressed in the context of oil field NORM where the defendants hold a valid lease to be upon the property, and indeed have the dominant estate, trespass to land and nuisance have been alleged in other types of radiation cases.

For example, in Maryland Heights Leasing, Inc. v. Mallinckrodt, Inc., adjoining business owners filed suit against a plant which produced radioactive pharmaceuticals seeking property damages allegedly caused by low-level radioactive emissions. However, Mallinckrodt never reached the ultimate issue of liability as it merely reversed the lower court, which had dismissed the claims for lack of subject matter jurisdiction. (The defendant had argued that the action was barred under the doctrine of federal preemption as the Nuclear Regulatory Commission had previously set emission rates, and the doctrine of political question.) In reversing the lower court, the Missouri Court of Appeals stated that the question of whether radioactive emissions constituted a physical interference with property presented an issue of first impression in Missouri. The court went on to hold that the complaint stated a claim in trespass, as well as nuisance, and reversed the lower court’s dismissal of plaintiffs’ claims.124

However, Good Fund, Ltd. v. Church did reach the issue of liability for trespass to property in a radiation contest. There, land developers brought suit for the alleged contamination of certain property purchased by them in the vicinity of the Rocky Flats Nuclear Plant. The defendants argued that testing showed the quantities of plutonium and americium on the plaintiffs’ land to be primarily at background levels and that although

124 Id. at 225-26.
125 Good Fund, Ltd. v. Church, 540 F. Supp. 519 (D. Colo. 1982).
some spots were higher than background, all levels were within the
guidelines set by the Environmental Protection Agency.\textsuperscript{126} In holding
that plaintiffs failed to state a cause of action for trespass, the \textit{Good Fund}
Court stated:

There is a point at which the entry is so trifling that the law will not
recognize it. As the magnitude of the intrusion diminishes, the magnitude
of the harm, i.e. damages, and the defendant’s conduct, i.e. degree of
intent or fault, are considered in evaluating whether the intrusion
constitutes an actionable trespass.\textsuperscript{127}

The entry in this case is of an amount of radioactive material which
produced no apparent physical changes in the land. Plaintiffs admit that
the issue of whether there are any risks associated with this level of
radioactive deposition is still a matter of speculation in the scientific
community. The evidentiary hearings show that opinions on this subject
tend to be influenced by political philosophy. It is my conclusion that the
plaintiffs can show nothing more than a potential harm from the deposition
levels on their property and that is not a sufficient invasion of their property
interest to be actionable.\textsuperscript{128}

Another radiation case wherein summary judgment was entered
against plaintiffs who sought damages for trespass to property from
radiation is \textit{Akins v. Sacramento Municipal Utility District}.\textsuperscript{129} There, a
group of more than 200 plaintiffs sought to recover damages from the
defendant based upon its operation of the Rancho Seco Nuclear Power
Plant. Their main allegation was that the defendant tortiously discharged
radioactive materials into waterways and the atmosphere. The trial court
granted summary judgment in favor of the defendants after concluding
that as a matter of law the radiation released by the defendant was not
harmful to the public in general or to the plaintiffs in particular, and that
it was not reasonably foreseeable that the releases would cause severe
emotional distress or property damage. This judgment was affirmed. In

\begin{itemize}
\item \textsuperscript{126} \textit{Id.} at 526.
\item \textsuperscript{127} Martin v. Reynolds Metals Co., 221 Or. 86, 342 P.2d 790 (1959), \textit{cert. denied}, 362
U.S. 918, 80 S. Ct. 672, 4 L. Ed.2d 739 (1960).
\item \textsuperscript{128} \textit{Good Fund} at 532-33.
\end{itemize}
Akins, whole body counts of the plaintiffs revealed that a substantial number of plaintiffs had received no dose exposure, while the majority of plaintiffs were below one millirem. The Akins court held that as plaintiffs had “failed to produce evidence of actual damage or physical invasion of the land they [had] failed to establish a triable issue of fact with respect to trespass.”

Therefore, the trespass issue will depend upon whether NORM plaintiffs in particular cases can establish that the NORM deposition levels on their property constitute more than mere potential harm.

[d] — Assault and Battery.

Black’s Law Dictionary defines battery as: “[i]ntentional and wrongful physical contact with a person without his or her consent that entails some injury or offensive touching.” Two cases which have considered whether exposure to radiation may constitute a battery are Field v. Philadelphia Electric Co. and Hennessy v. Commonwealth Edison Co. Both concerned radiation workers who alleged that their employers had subjected them to excess levels of radiation. In Field, the Superior Court of Pennsylvania held that the employee did state a claim for battery where the employee alleged that his employer deliberately operated its nuclear reactor so as to douse him with radioactive steam while knowing the employee was in a position of danger. The Field court stated that the intentional act of venting the radioactive steam upon the plaintiff was sufficient to satisfy the intent requirement for an actionable battery where, as in this case, the defendant knew that serious bodily injury was the likely result of the exposure.

The case of Hennessy v. Commonwealth Edison Co. stated that the plaintiff must “establish that [the defendant] committed intentional acts resulting in offensive contact with [the plaintiff’s] person, and that [the

130 Id. at 799-800.
131 Id. at 810.
132 Good Fund, 540 F. Supp. at 533.
134 Field, 565 A.2d at 1178.
plaintiff] did not consent to such conduct” in order to state a cause of
action in battery. The Hennessy court further stated the test as whether
the plaintiff could show that the defendant employer “engineered” a
radiation release or knew that a radiation release was substantially likely
to occur in an amount and manner that would cause contamination.

Therefore, plaintiffs in NORM cases should have to prove that the
defendant operator knew a radiation release in an amount sufficient to
cause bodily injury or contamination was occurring, or was substantially
likely to occur, in order to recover on an assault and battery theory.

[e] — Infliction of Emotional Distress.

Plaintiffs additionally assert claims for negligent or intentional
infliction of emotional distress. With regard to intentional infliction of
emotional distress, a defendant must either intend the harm or perform an
act while knowing that harm is substantially likely to occur as a result. As
NORM plaintiffs likely cannot meet this burden, the more probable
battleground is that of negligent infliction of emotional distress.

A majority of jurisdictions still hold that a physical injury or impact
is required before a plaintiff is entitled to recover for negligent infliction
of emotional distress. Except in cases which arise from pipe cleaning
facilities where it is alleged that bodily injuries are present, most NORM
plaintiffs do not claim physical injuries stemming from NORM and have
not sought medical treatment. The case of Akins v. Sacramento Municipal
Utility District, discussed supra in regard to battery claims, is instructive
on this issue as well. There, where plaintiffs showed no body burden of
radiation exceeding those dosages set by the Nuclear Regulatory
Commission and the Environmental Protection Agency, the Court stated:

In the circumstances presented here we are satisfied that there
is no basis for finding a duty on SMUD’s part to protect
plaintiffs from the type of harm which they allege. The factors
we find determinative are: (1) no one, including any of the
plaintiffs, suffered any actual physical harm as a result of

135 Hennessy, 764 F. Supp. at 507.
136 Id.
SMUD’s conduct; (2) no one, including any of the plaintiffs was actually exposed to harmful or legally cognizable levels of radiation; (3) none of the plaintiffs were percipient witnesses to SMUD’s allegedly negligent conduct and none of the plaintiffs had a contemporaneous awareness of the event and its consequences; (4) in fact, there was no “event” which caused injury; (5) plaintiffs received the information upon which their claims are based from media reports and other third parties. Under these circumstances plaintiffs obviously cannot claim damages for emotional distress . . . . To recognize a cause of action in the plaintiffs for negligent infliction of emotional distress would be to recognize such a cause of action in virtually anyone who is or has been in arguable proximity to Rancho Seco since 1980 based upon conduct which did not cause any actual injury.138

Therefore, in order to recover for negligent infliction of emotional distress, NORM plaintiffs should have to prove actual bodily injury causally connected to NORM exposure.

[f] — The Right of Lessee to RemEDIATE NORM Sites.

Although plaintiffs allege in their complaints that NORM constitutes a hazard to themselves and the public, they nevertheless have sought preliminary and permanent injunctions against operators who attempt to remediate their NORM locations. Plaintiffs argue that to allow remediation would amount to spoilation of evidence. This issue has been addressed by the federal court of Mississippi in Brown v. American Exploration Co.,139 where Judge Tom Lee characterized plaintiff’s position as an “unusual situation . . . [where] the plaintiffs seek to prevent by injunction

138 Id. at 808.

139 Brown v. American Exploration Co., No. 4-94-cv-56-LN, U.S. District Court for the Southern District of Mississippi, Eastern Division, remanded to No. 94-0037, Circuit Court of the First Judicial District of Jasper County, Mississippi.
what they seek to effect by the lawsuit.” In Brown, Judge Lee found that the plaintiffs could not show either a substantial likelihood of success on the merits of their claim, a substantial threat that they would sustain irreparable injury if the injunction were not granted, that the threatened injury outweighed the harm to the defendants, or that granting the preliminary injunction would not disserve the public interest, all of which plaintiffs were required to show prior to injunctive relief.

Judge Lee further found:

Under their lease agreements and state law, defendants have not only the right but arguably also the obligation to clean up these areas. The contracts of all the defendants grant the lessees the absolute right at any time during or after expiration of the lease to remove all property and fixtures placed on the land. To the extent that the plaintiffs would seek to prevent defendants from removing all property and fixtures, their position [sic] is without merit by virtue of contract terms.140

Although Judge Lee’s opinion has not disposed of this issue altogether, it does strengthen defendants’ remediation arguments.

[g] — The Measure of Damages: Restoration Costs Versus Value of the Property Before and After the Injury

A problematic, yet extremely important, issue in NORM litigation is the measure of damages to be used in awarding damage to real property where the cost of NORM remediation exceeds the fair market value of the land when uncontaminated. Defendants have argued that cost of remediation is not the proper measure of damage when such costs exceed the fair market value of the property before the injury. In Mississippi, at least, there is favorable case law to support this argument.141

140 Id.
141 See Lloyd Wood Construction Co. v. Little, 623 So. 2d 968, 974 (Miss. 1993)(stating, “Here we deal only with land, not an improvement or a severable asset. Restoration costs may not exceed the total value of the acreage.”).
An oil and gas case which has addressed this issue has also held that cost of restoration may not exceed the diminution in value of the property before and after the injury. As stated in *Bynum v. Mandrell Industries*:\(^\text{142}\)

Damages arising from temporary injury to land may be measured by different standards, depending on the varying circumstances of each particular case. *Where the injury to real property is merely temporary, or where property can be restored to its original condition, the measure of damages may be, or should include, the cost of repairs or restoration, as where the injury is susceptible of a remedy at a moderate or reasonable expense, and the cost of restoration may be shown with reasonable certainty, or where the cost of restoration is less than the diminution in the value of the property.*

Although this issue has been favorably resolved in other contexts and appears well ingrained in Mississippi law,\(^\text{143}\) it is not at all clear how the issue will be resolved if a NORM plaintiff is successful in convincing a judge or jury that NORM is harmful to health or if there is a significant

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\(^{142}\) *Bynum v. Mandrell Industries*, 241 So. 2d 629 (Miss. 1970).

\(^{143}\) For example, Mississippi Model Jury Instruction 20.30 Damages: Injury to Real Property; Elements to Consider provides:

Should you find for the plaintiff in this case, then you are instructed that, in determining the damages you should award for the injury to plaintiff’s (land)/(buildings), you should consider the difference between the market value of plaintiff’s property before the injury and the value after the harm was done. However, should a preponderance of the evidence show that plaintiff’s property can be restored to its condition before the injury, then you should award as compensation that sum which reflects the reasonable cost to repair plaintiff’s property, unless the cost of such repairs would be greater than the market value of the property before the injury. If the preponderance of the evidence shows that the reasonable cost of repairs would exceed the market value of the property before the injury, then you are instructed that, in awarding damages to the plaintiff, you should consider the difference between the market value of the property before the injury and the market value of the property after the harm was done. (emphasis added).
Chapter 2.11: Conclusion

Litigation over NORM contamination of oil and gas well sites is in its infancy. Although many cases have been filed, none of them have yet reached the appellate level. Thus, there remain many unanswered questions. One thing is clear, however; under the current levels set by existing and proposed NORM regulations, a significant number of well sites will be deemed contaminated and remediation will be an enormous expense for those who have owned, operated, or worked at such a site. The certainty of this expense along with the continued threat of litigation is capable of bringing drilling and production activity to a complete halt, especially in marginal fields. The industry should consider a systematic remediation of all abandoned contaminated well sites before litigation is filed, and it should implement programs to inhibit the production of NORM-contaminated scale in the produced fluids resulting from oil and gas operations.