Is Anyone Regulating Naturally Occurring Radioactive Material?
A State Survey

E.M. Gross
and
S.G. Barisas

August 1993

DISCLAIMER
This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

The submitted manuscript has been authored by a contractor of the U.S. Government under contract No. W-31-109-ENG-38. Accordingly, the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED.
ABSTRACT

As far as we know, naturally occurring radioactive material (NORM) has surrounded humankind since the beginning of time. However, recent data demonstrating that certain activities concentrate NORM have increased concern regarding its proper handling and disposal and precipitated the development of new NORM-related regulations.

The regulation of NORM affects the management of government facilities as well as a broad range of industrial processes. Recognizing that NORM regulation at the federal level is extremely limited, Argonne National Laboratory (ANL) conducted a 50-state survey to determine the extent to which states have assumed the responsibility for regulating NORM as well as the NORM standards that are currently being applied at the state level. Though the survey indicates that NORM regulation comprises a broad spectrum of controls from full licensing requirements to virtually no regulation at all, a trend is emerging toward recognition of the need for increased regulation of potential NORM hazards, particularly in the absence of federal standards.

WHAT IS NORM?

Radiation occurs naturally throughout the environment. For example, the sun’s rays consist of radiation, and radiation emanates from the earth’s crust as a result of such elements as uranium, thorium, radium, potassium, and radon gas (Thompson and Goo). Through natural pathways, radioactive materials may become part of the food and water supply. Because radioactivity is present in the earth’s elements, it can also be present in certain man-made substances such as building materials and fertilizer. Although the presence of naturally occurring radiation has long been recognized, recent data have increased concern that certain activities may inadvertently concentrate NORM causing undesirable, albeit low-level, radiation exposure to the general public. Consequently, efforts to regulate NORM have escalated.

Much of the NORM research has occurred in the oil and gas industry. Since at least the 1930s, radionuclides have been recognized in petroleum reservoirs (U.S. Environmental Protection Agency 1991). It was not until the 1980s, however, when NORM was detected in British North Sea oil and gas operations, that the extent of its presence became known. The American oil and gas industry became aware of specific sources of NORM in 1986, when NORM was discovered in tubing being removed from a Mississippi well. Comparable contamination found in other locations (American Petroleum Institute 1992) caused industry to begin aggressively researching NORM-related issues. Industry determined that processes involved in producing oil and gas tend to concentrate the NORM that exists naturally. These concentrations were found at levels considerably above background, and concerns arose regarding potential health hazards.

This work is sponsored by the U.S. Department of Energy, Assistant Secretary for Environmental Restoration and Waste Management, under contract W-31-109-Eng-38.
Though much of the regulatory activity regarding NORM has been directed toward oil and gas industry wastes, other sources of NORM have been investigated and studied as well. The Environmental Protection Agency (EPA) has identified no less than 50 waste streams that contain NORM.

**Discrete and Diffuse NORM**

NORM wastes have been divided for certain purposes into two subcategories: discrete and diffuse NORM. Discrete NORM tends to be low-volume, high-activity sources including items such as radium sealed sources, certain water treatment ion exchange resins, and, at high concentrations, the scale and sludge that accumulate in oil and gas production equipment, mainly piping (Nussbaumer 1993). Diffuse NORM is typically very large-volume, low specific activity sources such as mineral extraction by-products and tailings, oil and gas extraction by-products, certain coal fly-ash treatment wastes, and some uranium mining residues (Domsife 1992). The radionuclides of major concern in NORM are radium-226, radium-228, and some of their daughter products formed through radioactive decay (White 1992).

**FEDERAL V. STATE REGULATION**

The potential for regulating NORM as a waste category exists at the federal level, and federal regulation may occur in the future. Nationally, however, neither the Nuclear Regulatory Commission (NRC) nor the EPA categorically regulates the handling and disposal of NORM. The Environmental Protection Agency is presently developing radioactive contamination standards, which will address both cleanup levels and waste management, but has not yet determined whether NORM will be covered in this current rulemaking process (SAB 1993). EPA has also issued two draft reports, *A Preliminary Risk Assessment for Management and Disposal of Oil Field Waste and Piping Contaminated With NORM in the State of Louisiana* (Louisiana Study 1993) and *Diffuse NORM - Waste Characterization and Preliminary Risk Assessment* (April 1993), a scoping study to help determine whether EPA should propose regulations for the control of NORM. At present, however, federal regulation of NORM tends to be limited to circumstances in which specific radionuclides exceed threshold levels.

As publicity regarding NORM has increased, states have debated the extent to which they should assume the responsibility for its regulation. The current status of state NORM regulation is addressed in detail below.

**STATES WITH SPECIFIC NORM PROGRAMS**

At this time, Arkansas, Louisiana, Mississippi and Texas (referred to as "NORM" states) are the only jurisdictions with fully promulgated regulatory programs that specifically and separately license NORM. Additional states, including New Mexico, Kentucky, Alabama, Colorado, Oklahoma and New Jersey are in the process of developing similar regulations. Using a slightly different approach, Michigan has chosen to issue broadly applicable NORM standards
in the form of guidance rather than regulations.\(^1\)

The states that have developed separate regulations for licensing NORM have based them largely on a draft model regulation formulated by the Conference of Radiation Control Program Directors (CRCPD). Referred to as Part N, this model regulation is intended to provide guidance to the states in developing licensing requirements specific to their individual NORM problems. Part N describes the qualifications and procedures for the issuance of general and specific licenses. In addition, it identifies standards for exemptions, decontamination, and release to unrestricted use. Worker protection standards are referenced, and certain disposal requirements are listed.

With some variations, the Arkansas, Louisiana, Mississippi, and Texas regulations all follow the CRCPD Part N format. For example, the regulatory exemptions for NORM in the four "NORM" states are similar, though not identical, both to Part N and to each other. Table 1 lists these exemptions. As the table indicates, all four states exempt NORM with radium concentrations below 5 pCi/g. Louisiana, Mississippi and Texas also provide for exempt concentrations below 30 pCi/g where the radon emanation rate is less than 20 pCi/m²-s. Texas is the only state to provide an exempt standard applicable to recycled materials, which is an exposure level of 50 μR/hr including background radiation at any accessible point.

The new regulations adopted by the NORM states also include standards for release of land or equipment to unrestricted use. In Arkansas, Mississippi, and Texas, facilities and equipment must not be released to unrestricted use unless they meet acceptable surface contamination levels similar to those found in NRC Regulatory Guide 1.86. These state-imposed limits are described in terms of average, maximum and removable contamination levels and have been reiterated in appendices to the respective state regulations. The Texas regulations have simplified Regulatory Guide 1.86 by referring solely to NORM, rather than to individual radionuclides, and by employing only one set of numbers: 5,000 dpm/100 cm² average; 15,000 dpm/100 cm² maximum; and 1,000 dpm/100 cm² removable contamination levels. In Louisiana, the regulations do not refer to a Regulatory Guide 1.86-type appendix, but instead state that equipment may not be released to unrestricted use if the maximum radiation exposure level exceeds 25 μR/hr above background radiation.

Three of the four NORM states also prohibit the release of land to unrestricted use unless the concentrations in the soil meet standards similar to those established by EPA for uranium mill tailings sites. In Arkansas, land may not be released for unrestricted use if the concentration of radium-226 or radium-228 exceeds 5 pCi/g above background averaged over the first 15 cm of soil and 15 pCi/g above background averaged over each subsequent 15-cm-thick layer of soil. The standards in Louisiana and Mississippi are similar except that, like their exemption standards, they permit soil concentrations of up to 30 pCi/g where the radon

\(^1\) Michigan also regulates one aspect of NORM through a Michigan Department of Natural Resources Supervisor of Wells Order, which describes requirements for handling NORM-contaminated well casing. [Michigan Department of Natural Resources, Supervisor of Wells Order No. 3-6-92, Supervisor of Wells Order No. (M) 1-6-92].
Table 1.

<table>
<thead>
<tr>
<th>Exemptions</th>
<th>AR</th>
<th>LS</th>
<th>MS</th>
<th>TX</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5 pCi/g of radium(^1)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>&lt;0.05% by weight of thorium or uranium</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>&lt;30 pCi/g of technologically enhanced radium-226 or radium-228, averaged over any 100 m(^2), provided the emanation rate does not exceed 20 pCi/m(^2) s(^{-2})</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>150 pCi/g of any other radionuclide</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Equipment that does not exceed 25 (\mu)R/h above background</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Equipment and recycled materials that do not exceed 50 (\mu)R/h including background</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Persons who receive products or materials containing NORM distributed in accordance with a specific license issued by the appropriate state agency or equivalent agency in another Licensing State(^3)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Persons who receive source material under a general license</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Persons who receive, possess, store, use, process, transfer, sell, manufacture, distribute, or dispose of raw materials, intermediates, process streams, products, byproducts (including bauxite refinery and phosphogypsum reuse raw materials and products), and wastes related to the production of bauxite refinery and phosphate fertilizer materials, products, and byproducts</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>The manufacturing, distribution, use and disposal of:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>potassium and potassium compounds that have not been isotopically enriched in the radionuclide K-40;</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Brazil nuts;</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>byproducts from fossil fuel combustion;</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>materials used for building, industrial processes, metal casings and abrasive cleaning (the TX regulations use the specific term sand-blasting), if the NORM content of such material has not been technologically enhanced.</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
</tr>
</tbody>
</table>

\(^1\) The AR regulations refer simply to radium; the Louisiana, Mississippi and Texas regulations refer to radium-226 and radium-228. In addition, the exemption limits for MS and LA are characterized as "above background," while those in TX and AR regulations are not so characterized.

\(^2\) MS and LA regulations describe the standard as "< 30 pCi/g;" the TX regulations describe it as "30 pCi/g."

\(^3\) The TX regulations exempt products rather than persons receiving them.
The wholesale and retail distribution (including custom blending), possession, and use of the following products/materials:

<table>
<thead>
<tr>
<th>Product/ Material</th>
<th>TX</th>
<th>AR</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>phosphate and potash fertilizer;</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>phosphogypsum for agricultural uses;</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>materials used for building construction if such materials contain NORM that has not been technologically enhanced;</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>natural gas and natural gas products;</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>crude oil and crude oil products.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

The possession and use of natural gas, and natural gas products, and crude oil, and crude oil products as a fuel. The manufacturing and distribution of natural gas and crude oil and natural gas and crude oil products are exempt from the specific license requirements, but are subject to general licensing requirements.

Produced water from crude oil and gas production

<table>
<thead>
<tr>
<th>TX</th>
<th>AR</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Produced water from crude oil and gas production if reinjected in an approved well

<table>
<thead>
<tr>
<th>TX</th>
<th>AR</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

---

4TX regulations includes the "recycling of equipment or containers used to produce, contain or transport these products."

5AR regulations read "...if it has not been technologically enhanced." MS regulations read "...provided such commercial distribution and uses meet the requirements of 40 CFR 61.204."

6AR regulations include highway construction.

7MS regulations include transportation; TX regulations include storage and transportation.
emanation rate is less than 20 pCi/m²·s. The Texas regulations, as finally adopted, eliminated the "release to unrestricted use standard for land.

Of the four states that have developed NORM licensing regulations, three include disposal requirements within those regulations. (In the fourth state, Texas, disposal regulations are being separately developed by two different regulatory authorities.) In general, the regulations in Arkansas, Louisiana and Mississippi authorize disposal: 1) in a licensed facility, (2) in accordance with EPA-developed requirements, (3) in a manner equivalent to the requirements for uranium and thorium byproduct materials, or (4) in accordance with alternate authorized disposal methods. Louisiana has published a guidance document that describes some disposal options that regulators will consider approving, including, among others, deep well injection and disposal in plugged and abandoned wells.

STATES WITHOUT SPECIFIC NORM PROGRAMS

Many states, referred to here as "non-NORM" states, have neither developed specific NORM licensing regulations nor published voluntary guidance. However, whether these states may nonetheless be said to regulate NORM in certain respects is a complex question.

Most states have some form of radiation control program, created by statute and enforced through implementing regulations. Typical for laws related to public health, these statutes and regulations tend to be broadly crafted to facilitate timely government intervention. Such breadth, however, can sometimes cause confusion among both the regulated and regulators.

In order to better assess this less well-defined regulatory process, a state survey was conducted of radiation control divisions in all the non-NORM states. Regulators were asked about: (1) sources of NORM in the state, (2) whether the state had developed a "below regulatory concern" level for NORM, (3) existing requirements for licensing, registration and radiation protection as related to NORM (4) whether general radiation standards for decontamination and cleanup applied to NORM, (5) disposal options for NORM, and (6) potential NORM regulation in the state. The results of that survey are summarized below.

Sources of NORM

In non-NORM states, not all state regulators perceive NORM to be a serious problem. Where NORM is a concern, however, the most commonly reported sources are contaminated pipe and pipe scale from the oil and gas industry, scrap metal, filters and sludges from water treatment processes and facilities, phosphate fertilizer, and materials related to geothermal energy production. Additional, though less common, sources include zircon sand used in the exotic metals industry in Oregon, sludge from old glass-grinding operations in New York, radon-emitting discarded propane gas tanks in West Virginia, and equipment contaminated during the mining of kaolin clay in Georgia.

Establishing "below regulatory concern" Levels (BRC)
In 1990, the NRC issued a new policy "for determining when radiation levels are so low that they do not warrant further regulatory control" (55 FR 27522), known as the BRC policy. Though the NRC and its predecessor agency, the Atomic Energy Commission (AEC), had been making certain types of BRC decisions for decades, the publication of this policy caused a political explosion. Certain states reacted quickly and angrily to the policy. Vermont enacted legislation specifically prohibiting federal imposition of a BRC in that state. A Wisconsin statute states that "no material classified as below regulatory concern may be disposed of in a landfill in Wisconsin." The response to BRC levels was so negative that eight months after issuing the policy, the NRC withdrew it for further consideration.

The establishment of state BRC levels remains controversial. Of the states surveyed, only Utah regulators stated that a specific NORM BRC concentration level of 15 pCi/g had been established by regulation (Utah Radiation Control Rules, R-447-19-13(2)(a)(i)(B)). Nonetheless, a number of states have proceeded to develop standards that function as BRC levels of sorts. For example, in Arizona, material with radioactive concentrations below 2 pCi/g may be treated as essentially nonradioactive. In Michigan, radioactive waste with concentrations below 50 pCi/g may be sent to specially designed landfills, and in Minnesota a limited BRC standard could be said to exist for radium-contaminated water treatment wastes as set out in the state Guidelines for Disposing Radium-Containing Wastes Generated During Radium Removal from Drinking Water.

**Licensing, Registration, and Radiation Protection Standards**

On the basis of the definitions in many state regulations as well as states' traditional authority in the area of general health and safety standards, many states appear to have the authority to license or register sources of NORM. The authority granted within many state statutes is sufficiently broad to permit the licensing of NORM with no further legislative or administrative action. However, most states have chosen not to license NORM under their current regulations, particularly in its diffuse forms.

The NORM that is licensed is likely to be a sealed source or other discrete type of NORM. Because the regulations typically apply to "licensees," or "registrants", unlicensed, unregistered NORM would seem to remain unregulated in those states. Regulators were specifically asked, therefore, whether any of the radiation protection standards established for licensed materials were applicable to currently unlicensed, unregistered NORM. Regulators were divided in their responses.

Some regulators simply stated that regulations directed to licensees would not be applied to unlicensed sources of NORM. However, at least an equal number of regulators argued (1) that the purpose of the radiation control regulations is the protection of public health; (2) that any non-exempted source of radiation has the potential to endanger public health; and (3) that

---

2 According to a special report by Margaret L. Ryan, "Outlook on BRC," "[t]he law books include 39 specific exemptions for uses whose exposures are considered so minor that federal regulators saw no health danger in them" (Ryan 1991).
all nonexempted sources must, therefore, be handled according to the regulations, regardless of licensing status.

**Decontamination and Cleanup**

Regulators in states without specific NORM programs generally stated that their programs incorporated no decontamination and cleanup standards that specifically addressed NORM. When faced with a particular cleanup or decontamination activity, the regulators look to a variety of related standards developed at the federal and state level and apply them on a case-by-case basis.

The standards most commonly referenced by regulators were the NRC Regulatory Guide 1.86 and the EPA’s cleanup standard for uranium mill tailings (40 CFR 192), both of which have largely been incorporated as the standards in NORM states.

**Disposal Options**

Disposal continues to be among the most problematic issues surrounding NORM. The federal abandonment of a BRC policy, at least temporarily, as well as the reluctance by state legislatures to develop their own BRCs, has left NORM holders with few alternatives for approved disposal.

As previously noted, many states have enacted legislation prohibiting all land disposal of radioactive materials. Regulators state that, under such statutes, materials with "detectable" levels of radiation can not be sent to landfills. Only a few states, like Michigan and Utah, have specific exempt concentrations for land disposal as part of their regulations. In Michigan, radioactive concentrations below 50 pCi/g may be disposed of at a Michigan Type II Landfill. In Utah, materials with concentrations below 15 pCi/g are exempted from regulation and, therefore, may be land disposed. Most states, however, authorize land disposal on a strictly case-by-case basis. Such authorization is heavily dependent on the geographic and geologic conditions found at the proposed disposal site.

Occasionally, authorities encourage disposal methods uniquely suited to their state. For example, in Alaska regulators advocate grinding up large volumes of NORM-contaminated material produced at the North Slope and reinjecting it. The presence of permafrost is said to prevent migration of the reinjected material. In states with large numbers of abandoned oil wells, carefully contained downhole disposal may also be an approved alternative.

In most states, however, the only current disposal options for NORM that receive consistent, overt, and official approval are disposal in a licensed LLW facility or at Envirocare, located near Clive, Utah, which is the only facility in the United States specifically licensed to receive NORM wastes. Both options present problems for those wishing to dispose of NORM. Not all licensed LLW facilities are currently accepting NORM. The LLW facility at Hanford, near Richland, Washington, does accept NORM but imposes volume limits. Envirocare will accept NORM, but disposal costs are extremely high.
Regulators are aware that such circumstances often cause NORM to be stored on-site rather than disposed of. In some states, the regulated community has been advised to prepare their sites for long-term storage; the immediate focus of NORM programs in those states is the development of detailed storage requirements rather than standards for disposal.

POTENTIAL REGULATION

As previously stated, some of the non-NORM states intend to develop NORM-licensing regulations in the relatively near future. Regulators in all of those states report that the Part N model, as well as programs already developed by other states, will likely serve as the basis for their regulations.

However, in many of the states surveyed, regulators do not expect to develop any further regulations for NORM. The reasons include:

- Belief that NORM is not a problem in the state;
- Budgetary constraints;
- Belief that their current regulatory program is sufficiently comprehensive, as it relates to NORM, that additional regulations are unnecessary.

A common perception among these regulators is that the breadth of their statutory authority to regulate all nonexempt, nonfederally regulated radioactive materials already permits them to assert some level of control over NORM, including unlicensed NORM.

CONCLUSION

There is a growing conviction that NORM can create radiation hazards and waste concerns (Mississippi Regulations Rationale). The states with new NORM regulations have translated this conviction into (1) NORM soil contamination limits, (2) criteria for NORM-contaminated facilities and equipment released for unrestricted use, and (3) rules for proper handling and disposal of NORM-contaminated materials, all of which closely track existing regulations and guidelines for other sources of radiation.

Undoubtedly, as the need for appropriate, uniform standards is increasingly recognized, formal NORM regulation will accelerate. However, the extent and source of the regulation remains uncertain. Federal options to regulate NORM are still under discussion. It appears unlikely that the NRC will expand its regulatory authority to incorporate NORM (Nussbaum 1993) (Secy document 92-325 1992). The EPA may include NORM in the residual radiation regulations it is presently developing or address NORM in a separate future rulemaking. Until the EPA takes such steps, however, the focus of NORM regulation will stay with the states.