The *NORM* Report

Naturally Occurring Radioactive Material Contamination in the Petroleum Industry
Winter 1993

Index

P. Gray & Associates

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Regulations for the Control of NORM - Update

Recent developments in the regulations for the control of NORM are summarized below. A complete status report of NORM regulations in the individual states, the federal government, and Canada will be included in the Spring 1993 issue of **The NORM Report.**

TEXAS

The new proposed Texas regulations for the control of NORM (Part 46) were sent out for public comment in February 1993. Comments are due back to the Bureau of Radiation Control by March 26. A public meeting on the proposed regulations was held March 17. If no major problems are encountered the proposed regulations will go to the Board of Health for approval in June with adoption of the regulations in July or August, 1993.

The proposed regulations are a rewrite of previous drafts eliminating the regulations for the disposal of NORM. Responsibility for disposal has been transferred to the Texas Water Commission.

The proposed regulations exempt radium below 30 pCi/gm if the radon emanation rate is less than 20 pCi per second per square meter. Material with higher radon emanation rates will be exempt at 5 pCi/gm concentrations. The Bureau of Radiation Control will follow the regulations with guidelines that will list types of materials that are "known" to have low radon emanation rates. The radon emanation rates will not have to be measured for these materials to qualify for exemption at the 30 pCi/gm level.

Materials in the recycling process, including scale or residue not otherwise exempted, and other equipment containing NORM are exempt from the requirements of the rules if the maximum radiation exposure level does not exceed 50 microroentgens per hour including the background radiation level at any accessible point.

The proposed rule contains sections which address worker protection; exemptions of materials that pose insignificant risk; activities to be included under a general license and provisions for use of the general license; and activities requiring a specific license and regulations concerning specific licensure.

The Texas Water Commission will issue concentrations of material that will be exempt from the disposal regulations in April with the full disposal regulations available in the summer. The disposal exempt levels will be the same as in the Bureau of Radiation Control's proposed regulations.

OKLAHOMA

A new draft of the proposed Oklahoma regulations for the control of NORM was issued in early March and will be discussed at the March 25 meeting of the Radiation Advisory Committee. The new draft exempts materials containing 30 pCi/gm or less of radium with no reference to the

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OKLAHOMA (Continued)

radon emanation rate. Materials in the recycling process are exempted if the maximum radiation exposure level does not exceed 50 microroentgens per hour including the background radiation level at any accessible point. This latter exemption is identical to the wording used in the Texas proposed rule.

KENTUCKY

A draft of a proposed administrative regulation governing NORM has been prepared by the Radiation Control Branch of the Department for Health Services. However, the internal review of that draft and its potential impact have not been concluded. Accordingly, the proposed regulation has not been filed with the Legislative Review Commission and changes in the proposed regulation may still occur.

COLORADO

A Bill for an Act Concerning Regulation for NORM has been submitted to the 59th General Assembly in the State of Colorado. The proposed bill defines "Exempt Naturally Occurring Radioactive Material" as any material that contains nuclides that are radioactive in their natural physical state and that are not manufactured. The concentration of such nuclides in exempt NORM shall be less than 30 pCi/gm of radium-226, less than 0.05% by weight of uranium and thorium, and less than 150 pCi/gm of any other such nuclide.

NEW JERSEY

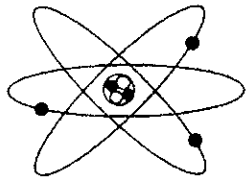
New Jersey issued a draft of intended revisions to their Subchapter 11 of the Radiation Protection Code. The title of the revised subchapter is "Generation, storage and disposal requirements for radioactive waste". An informal public discussion was scheduled for March 3. The draft is a preliminary draft; it is intended for discussion purposes only and in no way constitutes a formal rule proposal.

New Jersey's Department of Environmental Protection and Energy has become aware of certain industries which are accumulating large piles of radioactive waste on their facility grounds. While the wastes involve low concentrations of radioactivity, the piles often contain tens of thousands of cubic feet of waste material and, if not properly regulated, can become a significant source of radiation exposure to the public. Although New Jersey is not a petroleum producing state, it does have significant refining facilities which could be impacted by the regulations.

The proposed amendments establish the regulatory threshhold for NORM materials at 5 pCi/gm. The large volumes of diffuse radioactive waste currently being stored in the state and the volumes potentially generated may prohibit removal to off-site disposal facilities from an economic standpoint. For example, removing 550,000 cubic yards of thorium contaminated soil from several facilities located in Northern New Jersey to the only out-of-state disposal facility able to accept it (Envirocare of Utah) has been estimated to cost approximately $280 million. Therefore, in the proposal the department provides for, under strict guidelines and certain conditions, mixing of these radioactive wastes with soils as an acceptable waste management practice.

WASHINGTON

The State of Washington has recently completed a preliminary review of the various federal and state guidelines related to the control and disposal of NORM. Washington has not set up a timetable for NORM regulations, and is waiting for the CRCPD Part



N guidelines to be finalized before determining appropriateness of implementing similar regulations.

MINERAL MANAGEMENT SERVICE

The MMS regulates produced solids, i.e., sand, sludge and scal in off-shore production. Cleaned sand that had less than 25 microrems per hour from a one liter sample could previously be discharged. However, on January 15, 1993, the EPA notified MMS that no solids can be discharged from off-shore production -- that all solids would have to be brought on-shore.

ENVIRONMENTAL PROTECTION AGENCY

Both the Department of Energy and the Superfund program must deal with radioactive contamination at more than a hundred sites of various types. Th number is likely to increase, perhaps substantially, as federal site evaluations proceed, and as radioactivity sources not previously considered gain public attention. Examples of this latter category are accumulations of NORM in wastes from oil drilling and production and pipeline activities.

Congress has recognized this potential problem by directing the EPA to address the issue in a recent appropriation bill. The technical issues that should be considered in developing guidance should include the following:

(Continued on page 3)

EPA (Continued)

● The types and forms of radioactive substances at sites.

● A consistent protocol for exposure assessment and risk estimation that recognizes both spatial and temporal factors and the attendant uncertainties associated with human exposures to radiological contaminants at or from these sites.

● The degree to which other contaminants and biota may enhance or inhibit the on-site and off-site migration of radionuclides.

● Consideration of technical approaches for implementation of guidelines through managing radionuclide contaminants, and the effectiveness, costs, and cost/risk balancing for selected remedial actions.

EPA believes radon is one of the highest risk entities they are dealing with. Although the EPA "action level" for radon in homes and other inhabited structures is 4 pCi/l, there isn't good data available to support this concentration; i.e., it is not known if it should be 2 or 20 pCi/l. EPA does recognize that their data are severely limited when defining the risks of radon exposure. (Canada is thought to be considering 15 to 20 pCi/l as the action level for radon.)

EPA's concerns about radon concentrations are directly relative to the radium exempt concentrations expected in any NORM regulations or standards proposed by EPA. EPA believes that radon emanation from NORM is the greatest hazard from NORM exposure.

A draft report *Diffuse NORM Wastes - Waste Characterization and Preliminary Draft Assessment* was issued in May 1991. This draft report is a scoping study to help determine whether EPA should propose regulations for the control of NORM. Comments received on the draft are being incorporated into the report where applicable and the report is scheduled to be discussed at the April 1993 meeting of EPA's Radiation Advisory Committee of the Science Advisory Board. The final report is expected to be available by September 1993. This report may be the basis for regulatory action by EPA for the control of NORM.

Another EPA report on a risk assessment of oil field NORM wastes in Louisiana is underway. The report is looking at down-hole disposal options, near surface disposal, and evaluations of land spreading and land spreading with dilution. The EPA/LA report is expected to be released in draft form in March, 1993.

Current Superfund guidance suggests that any lifetime risk in excess of one in ten thousand is an obligatory (de maximus) basis for consideration of appropriate action. The risk goal may be as low as one in a million, which may represent a de minimus level for which no further action is required (exempt concentration). However, in the case of NORM, the radiation exposures that would produce such risks are far below variations in natural background levels. The EPA must establish whether the de maximus and de minimus values used for Superfund actions for chemicals are justified for radionuclides as well. The 4 pCi/l "action level" for radon in homes represents a lifetime risk of about one in a hundred.

The Radiation Advisory Committee of EPA believes it is appropriate to highlight these issues for attention by top EPA management, even if further consideration shows that their relatively low current priorities are well deserved. The distinction among NORM, residual radioactivity, and many of the other radiological entities that EPA has studied, e.g., uranium mill tailings, radon, radionuclides as hazardous air pollutants, and radionuclides as contaminants of drinking water, are largely legal and sociopolitical rather than scientific. Generally speaking, the degree of agency attention given various classes of radioactive materials has little correlation with the degree of risk they pose.

At the very least, EPA standards will be necessary to provide adequate regulatory control over NORM at federal facilities, since authority under state laws does not generally apply to those facilities. EPA has the authority under Section 6 of TSCA to regulate diffuse NORM wastes. In addition to the control options of Section 6, other sections of TSCA allow the EPA Administrator to designate other federal agencies to assist in implementing and enforcing the regulations. ■

"It is essential for our credibility that we do not become so narrowly focused that we cannot deal responsibly with total risk."

Risk to the Public from Exposure to Radon

Risk to the public from exposure to radon is far greater (about 1 in a 1000) than the 1 in a million risk standard established for most carcinogenic chemicals. The determination of what is "clean" for sites contaminated with radium will use background levels for establishing the standard.

The dominant risk to be addressed in developing a standard of "clean" for diffuse NORM comes from radon gas entering a house built on

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Risk to the Public from Exposure to Radon (Continued)

soils containing radium. The lifetime cancer risk from radon to persons in homes built on soils containing radium is on the order of one in a thousand or greater. The lifetime cancer risk from radon merely by breathing outdoor air is on the order of one in 10,000. Although theoretically possible, it is not practical to "clean" a radium contaminated site to a risk level of 1 in a million when the natural background levels carry a risk level 1,000 times greater. What can be done, is to permit a disposal solution that reduces the residual risk as low as reasonably achievable.

Soil mixing could be permitted to the extent that the resulting soil radium concentrations will not cause radon entering the lowest level of a building to exceed the regional natural background radon level or to exceed the local radon background radon level by 1 pCi/liter, whichever is less. Additionally, soil mixing should not cause the radioactive concentration of the soils to exceed, at any depth, 5 pCi/gm of radium.

Recent modeling by EPA staff of radon entry into houses from diffuse radioactive contaminated soils has demonstrated, for a range of soil types, that for radium contaminated soils with concentrations between 5.8 pCi/gm and 10.0 pCi/gm, the radon contribution to a typical house will be approximately 2 pCi/liter. Therefore, it is estimated that for radium concentrations between 3 and 5 pCi/gm the radon contribution to the lowest house level will be approximately 1 pCi/liter.

In a statewide study in New Jersey, it was found that 1 pCi/liter in a basement of a house generally results in approximately 0.4 pCi/liter (10% of the value at which EPA recommends remediation) of radon in the above living area. An incremental radon level of 0.4 pCi/liter in a living area represents an excess lifetime cancer risk of about 2 in a thousand, and this exceeds the 1 in a million risk which was used to develop proposed chemical cleanup standards. However, because natural background radon levels are significant, application of standard chemical risk assessment criteria to radionuclides leads to limitations on excess radiation dose that are very small in comparison to natural background levels. Application of the 1 in a million chemical standard to radionuclides, in addition to being extremely difficult to monitor for compliance because it is within the natural variability of background places a substantial economic burden on both public and private sectors with only limited further reduction, relative to background, in risk to the general population.

The above discussion is from the draft of intended revisions to New Jersey's Subchapter 11 of the Radiation Protection Code, dated January 20, 1993. ■

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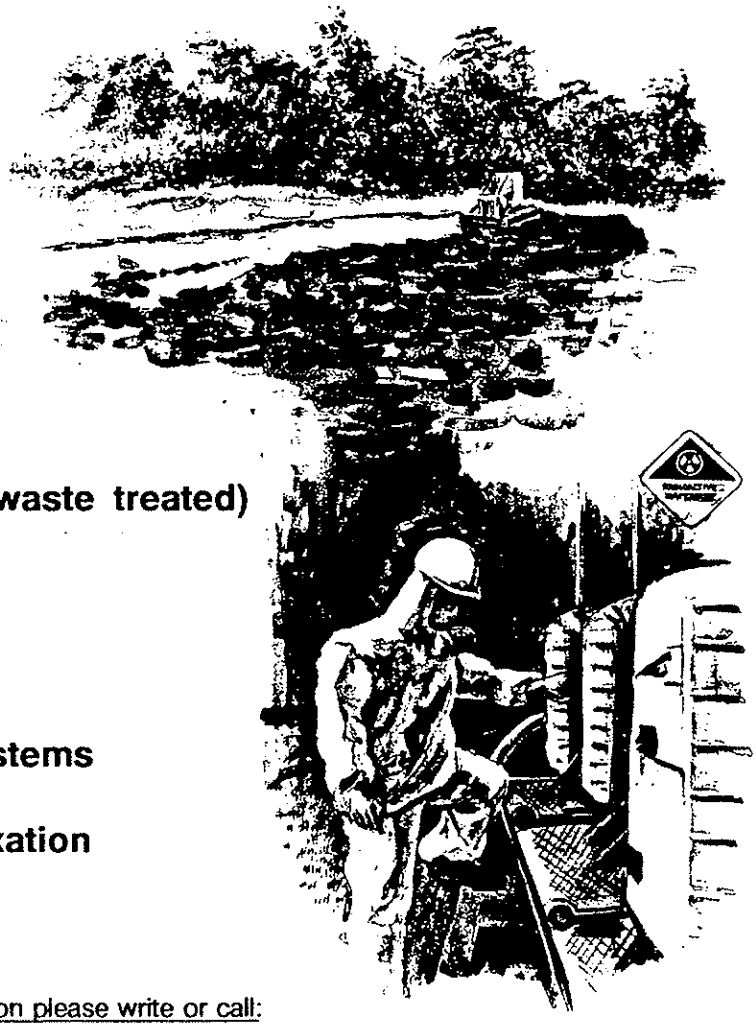

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Natural Radioactivity "Curative Spas"

In 1903 the discoverer of the electron, J. J. Thompson, wrote a letter to the journal *Nature* in which he described another remarkable discovery of his, the presence of radioactivity in well water. That the waters of many of the world's most famous health springs were also radioactive was soon recognized.

The radioactivity was due to the presence of radium emanation -- what we now call radon gas. The radon is produced by the radium present in the ground through which the waters flow. Being quite soluble, radon concentrations in ground water can reach very high levels.

Who would doubt that it must be the radioactivity that was responsible for the curative properties of the health springs? Certainly not Surgeon General Dr. George H. Torney, who wrote (circa 1920) that "Relief may reasonably be expected from various forms of gout and rheumatism, neuralgia, metallic or malarial poisoning, chronic Brights disease, gastric dyspepsia, chronic diarrhea, chronic skin lesions, etc. by bathing in the hot springs.

Further details were provided by Dr. C. G. Davis, who noted in the *American Journal of Clinical Medicine* that "radioactivity prevents insanity, rouses noble emotions, retards old age, and creates a splendid youthful joyous life."

Professor Bertram Boltwood of Yale explained the scientific basis for the cures in the following way: (The radioactivity was) carrying electrical energy into the depths of the body and there subjecting the juices, protoplasm and nuclei of the cells to an immediate bombardment by explosions of electrical atoms" and that it stimulated "cell activity, arousing all secretory and excretory organs ... causing the system to throw off waste products" and that it was "an agent for the destruction of bacteria".

Radon was believed to be so important to water that it was considered its life element. Without it, water was dead. Radon was to water what oxygen was to air.

Now that science had an explanation for the curative properties of the springs, the health spas and resorts associated with them began to do a booming business. Names were changed to include the magic terms "radioactive" or "radium". Visitors came from near and far to soak in the waters and inhale the air. Luxurious spas sprouted like weeds in Hot Springs, Arkansas. Good times!

With the realization of the hazards of radioactivity, e.g., deaths occurring among the radium painters, the public's appetite for soaking in radioactive waters cooled. But today in the United States, "curative spas" are still in existence. For example, the "radioactive water" signs have disappeared, but enough visitors still go to Hot Springs, Arkansas to warrant the recent opening of additional facilities.

Another option for those wanting the "cure" is to visit the uranium health mines in Boulder, Montana, where the air is radioactive and they are proud of it. In fact, the largest of the six operating mines even calls itself "The Free Enterprise Radon Health Mine." Its brochures attract visitors with the phrase "the unmedical approach to arthritis." Presumably such wording avoids classification as a medical claim and the legal restraints that would go along with it. ■

Comparitive Risks

A common estimate of the risks associated by exposure to radiation is described by the following comparison with every day life risks.

Based on statistical results, the absorption of 10 millirem represents an accountable risk of death of 1 in a million. The same risk of death is reached in life by the following listed activities:

- 600 kilometers of air travel
- 10 kilometers of driving a car
- one minute and five seconds of mountain climbing
- 3/4 of a cigarette
- two and a half weeks of contraceptive pills
- one-half of a bottle of wine
- three years of living close by a nuclear power plant

It should be noted that a 10 millirem dose is one-tenth of the yearly natural background radiation for everyone on earth. ■

Shell Offshore Injection Program

Shell with Baker Hughes Treatment Services NORM Team and Halliburton recently completed a slurrification and downhole injection program for the disposal of NORM contaminated wastes in offshore Louisiana. The program was started in early November 1992 and was completed in ten weeks, including mobilization, demobilization and decontamination time.

2400 - 2500 drums of NORM wastes were processed. The waste materials were slurried with water, ground to appropriate size for injection, suspended with viscosifiers and then injected. The final ratio of NORM slurry to NORM waste mixed was approximately 3 to 1 including decontamination waters.

About 5% of the waste were ungrindable. These waste materials, e.g.. nuts an olts, filters, plastic sheets, and personal protective equipment, were encapsulated in 5-1/2 inch pipe, welded shut about 4 to 6 inches from each end, and stored for later disposal. Another 80 joints were filled with yard cleanup waste materials and plugged. These joints will be disposed of in an onshore state well.

Shell was pleased with the disposal program. The injections went very well. Shell is presently calculating the cost of the program. ■

"To be a success in business, be daring, be first, be different." -----Marchant

BP Injection Program

BP Exploration (Alaska) Inc. (BPX) and ARCO Alaska, Inc., Co-Operators of the Prudhoe Bay oilfield, recently completed a test program for the disposal of NORM materials via injection in a Class II well. Five barrels of NORM wastes removed from a NORM scale contaminated heat exchanger during cleaning were injected in the program.

After the successful completion of the test program, a contractor has been retained to design and construct pipe cleaning and hydraulic injection facilities for the disposal of NORM waste materials.

SPE paper 25935 at the recent First SPE/EPA Joint Environmental Conference discusses the program (See references on page 9)
■

Street Inc. vs. Chevron

This classic NORM litigation suit was recently settled. Street Inc. operated a machine shop in Mississippi that was removing scale from used production pipe for Chevron and Shell. In April 1986, the machine shop was found to be contaminated with NORM -- the pipe scale was radioactive and on removal from the pipe contaminated the shop. Although scale was known to be contaminated with radium in the North Sea in the early 1980's, the possibility of contamination in the United States was not generally known before 1986.

The suit against Chevron and Shell was filed in September/October 1986. Subsequent to the trial, Shell settled. The Street Inc. vs Chevron trial had been underway about six months when Chevron settled right after Christmas 1992. The trial was the longest civil suit in Mississippi history.

This suit was the first litigation involving NORM in this country. Many more can be expected. For example, a landowner in Louisiana has retained an attorney to sue a company doing descaling of production pipe. The descaling contaminated the land and now Louisiana's DEQ has cited the landowner for violation of the regulations for the control of NORM. Eight acres of land are involved with seven or eight "hot" spots showing radiation contaminations up to 1000 microrems per hour with the hottest spot 3,000 microrems per hour. The background in the area is about 15 microrems.

Similar litigation can be expected in the future --- landowner vs. petroleum company, independent petroleum operator vs. major company, etc.

In the past few months, Louisiana's DEQ has increased their efforts in "forcing" cleanup of contaminated sites. ■

Radium Background

The average concentrations of radium-226 in the earth's crust is about 2 pCi/gm, and in the ocean waters about 0.07 pCi/gm. ■

Radon in Ground Water

The amount of radon in ground water ranges from about 100 to 3,000,000 pCi per liter. ■

Recent References on NORM

Characterization of Radioactive Petroleum Piping Scale with an Evaluation of Subsequent Land Contamination by A. J. Wilson and L. Max Scott, Health Physics, Vol. 63, No. 6, December 1992, pages 681-685.

Technical and Regulatory Issues Associated with Naturally Occurring Radioactive Materials (NORM) in the Gas and Oil Industry; prepared by Paul W. Spaite and G. Ray Smithson, Jr. for the Environment and Safety Research Department of the Gas Research Institute, April 1992. Report No. GRI-92/0178.

Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Industry Equipment and Wastes - A Literature Review by Gregory J. White, June 1992. Report DOE/ID/01570-T158 (DE92001050). Available from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

A Guide to Naturally Occurring Radioactive Material (NORM) in the Texas Petrochemical Industry; prepared by TCC Environmental Health Committee's ad hoc Radon Subcommittee for the Texas Chemical Council, February 1992. Available (?) from Texas Chemical Council, 1402 Nueces Street, Austin, TX 78701, (512) 477-4465.

The Radon News Digest, a publication dedicated to covering radon gas and related issues is published by Hoosier Environmental Publishing. The newsletter tracks the legal, medical, occupational, real estate, relocation and industrial issues related to radon. Contact Masha Carrington at (317) 843-0788, ext. 805.

The following papers on NORM were presented at the recent SPE/EPA Exploration and Production Environmental Conference - 93 in San Antonio, March 7-10, 1993. Copies of the papers are available from the SPE at P. O. Box 833836, Richardson, TX 75083-3836, (214) 952-9393.

NORM Cleaning and Disposal Using Closed-Loop Hydroblasting or Solvent Bath and Underground Injection System by D. J. Lowe, BP Exploration (Alaska), Inc. SPE 25935

An Operational Perspective on the Handling and Disposal of NORM in the Gulf of Mexico by B. E. Shannon, Arco E&P Technology. SPE 25936

NORM Scale Formation - A Case Study of the Chemistry, Production, Remediation, and Treatment in Wells of the Antrim Gas Fields by J. E. Oddo et al. SPE 25937

Disposal of Naturally Occurring Radioactive Materials from Operations on Federal Leases in the Gulf of Mexico by G. J. Rutherford and G. E. Richardson, Mineral Management Service. SPE 25940

Regulations for the Control of NORM by P. R. Gray SPE 26272 ■

US Army Corps of Engineers News Release

Naturally Occurring Radioactive Materials (NORM) to be removed from toxic and hazardous waste sites throughout the United States, and radioactive materials meeting limited concentration limits, have found a permanent disposal site, near Clive, Utah, through a contract recently awarded by the U.S. Army Corps of Engineers Kansas City District.

That site, operated by ENVIROCARE Inc. of Utah, can be used immediately by any federal agency needing both a contract and a disposal site for low-activity radioactive and mixed waste materials.

This sole-source requirements contract provides for Envirocare to receive and dispose of waste over a five-year period, with total charges not to exceed $100 million. Among the sites selected to utilize this contract is the Montclair, West Orange and Glen Ridge (N.J.) Radium superfund project which contains radium bearing materials. ■

NORM Training Course Offered by OGCI

OGCI (Oil & Gas Consultants International, Inc.), a world leader in petroleum training, has scheduled training courses in NORM control for 1993. The course ***NORM Contamination in the Petroleum Industry*** will cover all aspects of NORM contamination and its control, including:

- Fundamentals of Radiation
- Fundamentals of NORM
- NORM (Radium) Contamination
- NORM (Radon) Contamination
- State and Federal Regulations
- NORM Surveys including hands-on practice
- Maintenance Procedures
- Disposal of NORM Wastes
- Decontaminations
- Release of Facilities
- Recommended Programs

This in-depth course is taught by Peter Gray who has a background in nuclear and radiochemistry and 25 years experience in the petroleum industry. Dr. Gray has a Ph.D. in Nuclear Chemistry from the University of California at Berkeley. He took early retirement from Phillips Petroleum Company in 1985 after 25 years with the company. Since 1985, Dr. Gray has been a consultant in NORM contamination in the petroleum industry. During his tenure with Phillips, Dr. Gray was in charge of the company's NORM control program from the discovery of NORM contamination in natural gas and natural gas liquids in 1971 until his retirement in 1985. This background uniquely qualifies Dr. Gray as an instructor of the course -- an instructor who understands the origins of NORM, why it contaminates nearly every oil and gas facility, where the contamination occurs, how to set up programs which protect employees, company facilities, the environment and the public, how to survey for NORM contamination, the available options for the disposal of NORM contaminated wastes, and the federal and state regulations for the control of NORM.

The 1993 schedule for the course ***NORM Contamination in the Petroleum Industry*** is:

April 27 - 30	Houston
Nov 2 - 5	Dallas
Nov 16 - 19	Calgary

In-house courses can be arranged by contacting Joseph Goetz at OGCI..

For information about the course, contact Joseph Goetz, Vice President, OGCI, 4554 South Harvard Avenue, Tulsa, OK 74135, 800-821-5933. Or contact Peter Gray at 918-250-6042 for information about the course content. ■

NORM contamination is to be respected --- not feared

Legal Liabilities

Regulation of NORM establishes the definition, scope, and penalties associated with related legal liability. Due to the nature and variety of release mechanisms, NORM or NORM contamination has the potential to generate liabilities related to environmental damage and human exposure.

The potential for radiological exposure to the general public as well as to individuals in an occupational capacity adds further complexity to the assessment of calculated dose, related health risks, and levels of responsibilities. An additional concern relates to the extension of current operating standards and the assignment of liability to past activities.

Regulations for the disposal of NORM contaminated equipment and facilities in some form at the state or federal level is highly desirable for the protection from tort liability. If a company is acting within statuatory guidelines, then it is acting as a responsible and prudent member of the industry. This type of standard will be used to determine negligence should a lawsuit be brought against it. Compliance with regulatory authority will help to narrow a company's tort liability for harmful effects resulting from exposure to radioactive materials.

With the possible exception of transporting NORM contaminated waste to a licensed facility for proper disposal, the industry should be very wary of allowing any of the equipment or scale or sludge materials contaminated with NORM to be introduced into the stream of commerce. Without proper indemnification, disclaimers, and notice to the receiving party, a company would probably remain liable for any harm caused by the radioactivity of the piece of equipment or scale and sludge. ■

Radiation and Cancer

External radiation is a very inefficient way to produce cancer. As of 1982 the 100,000 atomic bomb survivors had about 350 excess cancer deaths caused by radiation -- only about 5% more than would be expected from natural causes. ■