TENORM/NORM IN THE UNITED STATES

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1 ABSTRACT

In the United States, TENORM wastes and consumer products are regulated by either Federal or State government agencies. Most agencies apply general radiation protection standards devised for all sources of radiation to TENORM. This is done to facilitate the protection of the public and occupational workers, identify appropriate types of waste disposal sites (cells), and decide upon guidance for clean-up of radioactively contaminated sites. However, some industries' generation of TENORM is controlled by specially designed Federal or State regulations (e.g., phosphate, oil and gas, elemental phosphorous, and uranium mining). Advisory organizations in the United States such as the Conference of Radiation Control Program Directors and Health Physics Society are in the process of proposing radiation protection standards or model regulations specifically for TENORM. At the same time, Federal government agencies such as the Environmental Protection Agency (EPA) and Nuclear Regulatory Commission (NRC) are working to resolve regulatory and jurisdictional issues on how old laws written for control of atomic energy or hazardous substances could be applied to TENORM. The U.S. National Academy of Sciences has provided recommendations that may impact how protection standards for sources of TENORM are developed in the country.

EPA previously estimated that over one billion tons of TENORM is generated in the United States annually. Much of this results from the extraction of mineral ores. Accumulations of TENORM in abandoned and un-reclaimed, or improperly reclaimed, sites may pose hazards to members of the public, especially if they are unaware of the contamination associated with this class of radioactive materials. A review of EPA's approach to TENORM to provide for education of the public and industry, or develop guidance, standards, or regulations if necessary, is detailed in this paper.

2 INTRODUCTION

Sources of Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) have been examined as health and safety hazards by the United States Environmental Protection Agency (EPA) since its formation in the 1970's. Early reports by EPA's radiation program staff examined levels of radiation in sources as diverse as natural gas, phosphogypsum, and mining wastes (e.g., U.S.

EPA, 1978, 1975, 1973). Although the disposal of high level nuclear waste from peaceful uses of atomic energy as well as weapons manufacture demanded more public attention, the impacts of TENORM as an ever present radiation problem resulted in passage of laws and implementing regulations in the 1980's and 1990's to control specific types of TENORM. In the new century, the conflict of either treating all TENORM wastes and products as one kind of radiation with similar handling and disposal options, or looking at them as individual sources of radiation with differing physical and chemical manifestations requiring differing treatments and disposal routes is a current issue of concern.

2.1 U.S. radiation Protection Law

The EPA and Nuclear Regulatory Commission (NRC)

TENORM as used in this paper refers to materials containing radionuclides not covered under the U.S. Atomic Energy Act (AEA) whose radioactivity has been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction or water processing. These substances were previously referred to as NORM in the U.S., but we are attempting to separate natural background radiation in undisturbed soil, rocks and water from those substances whose radiation was concentrated by human activities instead, giving the latter a TENORM tag.

An additional issue is that although any of the TENORM radionuclides, which include uranium, thorium, radium, and potassium, and their decay daughters, could be present in a TENORM waste or product, one U.S. Federal law—the Atomic Energy Act of 1954 as amended-- assigns health, safety, and licensing responsibility specifically for just uranium and thorium (termed "source material") to what is now the U.S. Nuclear Regulatory Commission. That law is silent about the other naturally occurring radionuclides. However, NRC has chosen not to license parties or individual operations which utilize uranium or thorium in concentrations below 500 parts per million. In fact, due to vagaries of the legal statute, mining operations are not licensed by that agency with the exception of *in-situ* uranium leaching facilities. The NRC also licenses radioactive waste disposal facilities. Under that agency's authorities, it can tender its statutory authority to States whose regulations and standards mirror those of the NRC. Because of this special situation, and judicial decisions affirming NRC authority over uranium and thorium, regulation of TENORM exposures, waste handling, and disposal becomes complicated.

More than a dozen major laws form the legal basis for the programs of the Environmental Protection Agency. EPA authority to develop radiation protection standards and to regulate radioactive materials including TENORM, is derived from a number of those Federal laws, plus Executive (Presidential) Orders.

The authority to develop Federal guidance for radiation protection was originally given to an organization called the Federal Radiation Council (FRC) in 1959 as an offshoot of authorities of the Atomic Energy Act of 1954 . Over the next decade the FRC developed Federal guidance ranging from exposure levels of the general public to estimates of fallout from nuclear weapons testing. Federal guidance developed by the FRC provided the basis for most regulation of radiation exposure by Federal and State agencies, prior to the establishment of the EPA.
In 1970, the responsibility for developing Federal guidance for radiation protection was transferred from the FRC to the newly formed EPA. Federal Guidance Documents are signed by the President and issued by EPA. By signing these, the President provides a framework for Federal and State agencies to develop regulations that ensure the public is protected from the harmful effects of ionizing radiation. Federal Guidance is also an opportunity for the President to promote national consistency in radiation protection regulations. For example, the guidance document *Radiation Protection Guidance to Federal Agencies for Occupational Exposure*, issued by EPA in 1987, established general principles, and specifies the numerical primary guides for limiting worker exposure to radiation. EPA is currently working with a number of other Federal agencies to develop modern U.S. guidance for radiation protection of members of the general public that would be more compatible with international standards for radiation dose and risk.

Beyond this authority, EPA has responsibilities for radiation emitted into what are termed "environmental media", either air, water, or land (in this case, as wastes). As one example[1], EPA regulates radon and radioisotope emissions into the air. Regulations promulgated by the agency specifically target emissions from:

- Underground Uranium Mines
- Department of Energy Facilities
- Elemental Phosphorous Plants
- Radon from Phosphogypsum Stacks

Under laws specific for radon abatement[2], EPA has also developed guidance for control of radon in buildings and schools.

With respect to water, one law[3] gave EPA the authority to establish water quality standards and regulate the discharge of pollutants into waters of the United States. Radioactive materials are included in the definition of pollutants and EPA's implementing regulation defines the term "pollutant" to include radioactive materials, except those regulated under the Atomic Energy Act. Thus EPA currently regulates radionuclides and radiation in discharges and establishes water

[1] Under authority of the Clean Air Act of 1970
[2] This includes the Radon Gas and Indoor Air Quality Research (1986) and Indoor Radon Abatement Act (1988), as well as authorities of the Clean Air Act.
[3] The Clean Water Act of 1977.

quality standards. This includes TENORM radionuclides, with the exception of uranium and thorium, based on the wording of that law and judicial decisions. Conversely, under another law[4], EPA sets standards for drinking water quality and oversees the States, localities, and water suppliers who implement those standards. In this case, regulatory standards are not restricted by radionuclide and have been set for uranium, radium-226 and radium-228, and address combined alpha, beta and photon emitters. Draft proposed limits are in preparation for radon.

In order to prevent releases or threatened releases of hazardous substances onto the land or water that may endanger public health or the environment, or remediate abandoned waste sites or materials, the laws which established the"superfund"[5] are used for removals and clean up of radioactively contaminated sites. EPA has developed guidances for establishing the clean up levels of soils contaminated with radiation from all sources including radium, thorium, and uranium. Waste disposal cells constructed to standards for superfund hazardous wastes could be used for disposing of certain types of TENORM with high levels of radiation. In a very few locations, based on State agency regulatory decisions, some waste disposal sites created for chemically hazardous wastes under another law[6] can also be used for TENORM.

Additional radiation protection authorities provided to the EPA by Congress include responsibilities for setting protective standards for radioactive waste disposal at two national repositories, the Waste Isolation Pilot Plant (WIPP)[7], and the proposed Yucca Mountain radioactive waste disposal site[8]. The standards to be developed were required to prescribe the maximum annual effective dose equivalent to individual members of the public from releases to the accessible environment from radioactive materials stored or disposed of in the repositories.

Current regulations applicable to remediation of both inactive uranium mill tailings sites, including vicinity properties, and active uranium and thorium mills have been issued by the EPA[9]. EPA's regulations apply to remediation of such properties and address emissions of radon, as well as radionuclides, metals, and other contaminants into surface and groundwater. The NRC was required to adopt the EPA standards, and it uses those to approve the closure of sites managing mill tailings, which then fall under the long term oversight and monitoring of the U.S. Department of Energy (DOE).

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[4] The Safe Drinking Water Act of 1974.
[5] Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (1980) and the Superfund Amendments and Reathorization Act (SARA) (1986).
[6] The Resource Conservation and Recovery Act (RCRA) (1976).
[7] Waste Isolation Pilot Plant Land (WIPP) Withdrawal Act, as amended.
[8] Authorized by the Energy Policy Act of 1992.
[9] EPA authority for this is derived from the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, as amended.

Other Agencies

The DOE has the responsibility[10] to protect human health and safety from the hazards of radiation and radioactive materials associated with research, development and production activities on its own lands. At its facilities, TENORM is regulated as a radiation source under the same policy and technical requirements that are applied to source, special nuclear, and by-product material under the Atomic Energy Act. However, the Department of Energy does not have the authority to regulate TENORM at facilities where it is not the owner.

Other land management agencies such as the National Forest Service, the Department of the Interior agencies (including the Bureau of Land Management, National Park Service, Bureau of Reclamation, and Fish and Wildlife Service), and Department of Defense agencies (Army, Navy, Air Force) are responsible for clean up and control of radioactive materials on their lands by virtue of either enabling legislation, or requirements of the laws to protect land, air and water described above. In addition, the U.S. Army Corps of Engineers is also responsible for clean up of certain sites, usually owned by private companies, formerly used for development of atomic energy or defense activities under contract to the government.

The U.S. Department of Transportation (DOT) has developed regulations under various laws[11] for the safe transportation of hazardous material (including radionuclides and TENORM) in intrastate, interstate, and foreign commerce. The latest IAEA radioactive material transport regulations[12] introduce appreciable changes in the definition of radioactive material, some of which will have direct impact on the commercial transport of TENORM, particularly if those changes are incorporated into regulations of the DOT, as currently planned.

The Occupational Safety and Health Administration (OSHA) in the U. S. Department of Labor has developed standards to protect employees from exposure to ionizing radiation. The agency's organizing law[13], removes from OSHA's coverage those working conditions for which another Federal agency (or a State agency acting under the Atomic Energy Act) has prescribed or enforced occupational safety and health regulations.

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[10] Under authority of the Department of Energy Organization Act of 1977 and the Atomic Energy Act of 1954, as amended.

[11] Transportation of radioactive materials is governed by requirements of the Transportation Safety Act of 1974 and the Hazardous Materials Transportation Authorization Act of 1994.

[12] Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised), No. TS-R-1 (ST-1, Revised).

[13] the Occupational Safety and Health Act of 1970.

States

State authority to regulate radioactive materials including TENORM is based on the Constitutional law tenet that any authority or responsibility not specifically assigned to the Federal government may be exercised by the States. Many States actively regulate radioactive material through radiation control and other State programs. Control under State law includes naturally occurring and accelerator-produced radioactive materials and other sources of ionizing radiation. Thirty-two States have entered into agreements with the NRC, under which that agency has relinquished regulatory authority over most radioactive materials used in non-Federal facilities. Most States also control radioactivity through programs laws authorized by the EPA to implement clean air, water and other environmental.

Whether or not an individual State has assumed regulatory authority from the NRC under an Agreement, each State has explicit statutory authority for regulating sources of ionizing radiation not otherwise regulated by the Federal government. Several non-agreement States (for example, Michigan and New Jersey) have asserted specific authority over TENORM, especially cleanup approaches and disposal. Ten have developed regulations specifically for TENORM, though many of those are specific to oil and gas TENORM. Most States regulate TENORM under general rules for radiation protection.

2.2 Other organizations ' TENORM efforts

Conference of Radiation Control Program Directors

Comprised of officials from State radiation control programs, usually health, natural resources, or environmental agencies, the Conference of Radiation Control Program Directors (CRCPD) for several years has been working to find solutions to exposure to radiation from TENORM sources. This non-profit organization has developed a series of model regulations, either to implement Federal regulations, or to provide new radiation protection controls if Federal regulations are not available. These regulations can serve as a potential model for each State to use in generating its own regulations, tailored to conditions in a particular State, for radiation protection standards, radionuclide or materials licensing, handling, transfer, and waste disposal.

A committee of the CRCPD has developed a number of draft proposals for control and licensing of TENORM materials. The most recent draft was submitted in 2001 to appropriate Federal agencies for review and concurrence: the EPA, NRC, DOE, and Food and Drug Administration[14] . After receiving the agency comments, the CRCPD may issue the model regulations for use of the States, should they choose

[14] The Food and Drug Administration is responsible for approval and licensing of X-Ray machines, medical radioisotopes, as well as irradiation of food, so is consulted by CRCPD on newly proposed model regulations.

to adopt them. If the Federal agencies do not concur in the regulation, CRCPD could either further revise them, or decide to issue them along with the Federal agency reasons for non-concurrence as a caution to States when they develop their own regulations.

Health Physics Society

A committee of the U.S. Health Physics Society has been developing a separate standard for TENORM radiation control, handling, transfer, storage, and disposal of those wastes and products. This professional organization is preparing its standard independently from the CRCPD with the intention of getting it approved for inclusion as an American National Standards Institute (ANSI) professional environmental standard. ANSI is a private, non-profit organization that administers and coordinates the U.S. voluntary standardization and conformity assessment system. The Institute promotes and facilitates voluntary private sector consensus standards and conformity assessment systems, and safeguards their integrity. As such, the standard might encompass the activities of individuals, organizations, and industrial corporations which utilize or produce TENORM wastes and products. A draft standard has been prepared under the auspices of the Health Physics Society, but is currently undergoing revision.

InterState Oil and Gas Compact Commission

The InterState Oil and Gas Compact Commission (IOGCC) is an association of State governors from oil and gas producing States. The organization is responsible for the promoting production and examining regulatory issues for oil and gas at the State level. The IOGCC's Environmental and Safety Committee formed a (TE)NORM Subcommittee several years ago to focus on issues related to the presence of (TE)NORM in production and processing waste streams. A final report prepared by its committee provided guidance to be used by State oil and gas regulators in determining appropriate regulatory controls for the petroleum industry (TE)NORM (IOGCC, Undated).

American Petroleum Institute

The American Petroleum Institute, an association for the U.S. oil and gas industry, has a (TE)NORM committee which has actively reviewed the occurrence, handling, and disposal of those wastes generated by that industry. It has published a series of reports and guidelines for oil companies for occupational safety, as well as for voluntarily controlling the accumulation of TENORM wastes, and suggested means of disposal (API, 1996, 1992, 1990).

National Council on Radiation Protection and Measurements

The National Council on Radiation Protection and Measurements (NCRP) is a non-profit organization chartered by Congress whose mission is to facilitate and

stimulate cooperation among organizations concerned with the scientific and related aspects of radiation protection and measurements. As such, the NCRP formulates and disseminates information, guidance and recommendations on radiation protection and measurements which represent a consensus view of its members. The NCRP has published a number of previous reports on TENORM including background radiation (NCRP, 1993, 1988, 1975).

National Academy of sciences Tenorm Study

In 1996 and 1997, the U.S. Congress requested that EPA arrange for the U.S. National Academy of Sciences (NAS), a private non-profit organization chartered by Congress, to conduct a study to investigate the scientific and technical bases for EPA's TENORM guidelines. Congress instructed that, as part of its investigation and report, the NAS Committee "…summarize the principal areas of agreement and disagreement among [EPA and other organizations] and . . . evaluate the scientific and technical basis for any differences that exist." EPA was to submit the completed NAS study to Congress, along with the Agency's own report on what it would do to implement the NAS's recommendations, including EPA's plans to revise its TENORM guidance documents.

To conduct this study, the NAS formed a committee which held a number of meetings, and examined and compared the existing guidelines for TENORM developed by EPA and other organizations concerned with radiation protection. These other organizations included the U.S. DOE, the NRC, the National Council on Radiation Protection and Measurements, the International Commission on Radiological Protection, the International Atomic Energy Agency, the Commission of European Communities, and the Health Physics Society. The NAS also reviewed guidelines published by the individual U.S. States.

The NAS report (1999) concluded that "differences in the guidelines for TENORM developed by EPA and other organizations are based essentially on differences in policy judgements for risk management". The NAS Committee also found that the information used to evaluate risk from ionizing radiation arising from TENORM and other (generally man-made) sources of ionizing radiation was, and should be, the same. The risk assessment methods for TENORM were found not to be different from methods used for assessing risk from other sources of ionizing radiation. This was because absorbed dose (or risk) depends on radiation type (e.g., alpha, beta, gamma) and its energy, not the source. The NAS found that all of the organizations use epidemiological data developed from radon exposures of underground miners as the basis for risk assumptions involving indoor radon. All the organizations they investigated also used the epidemiologic data gained from studies of Japanese atomic-bomb survivors, as extrapolated to the low doses of concern in environmental exposures, as the basis for TENORM guidelines, other than indoor radon. Finally, they found that all organizations that developed guidelines for TENORM accepted a linear, no-threshold dose-response

relationship at low levels of exposure. The NAS also concluded that different judgements on the maximum acceptable risk to the public have led to different risk management approaches. These approaches reflect in part the fundamental differences in each organization's statutory and judicial mandates, particularly a requirement to set a regulatory limit such as a standard that must be met, versus a regulatory goal that can be relaxed based on considerations embodied in other guidelines.

In its recommendations, the NAS Committee urged EPA to include in its assessment of TENORM-related risks an assessment of existing background radiation and the risks that this radiation contributes to overall risks from radiation exposure. It also recommended that EPA should examine further the chemical forms and physical structures of TENORM and should develop a more comprehensive system to document its various uses and dispersal. The NAS Committee suggested that EPA consider TENORM's bioavailability, leachability, and radon emanation rates in the agency's assessments of the effects of radiation exposure, and also consider the effects of the hazardous chemical agents commonly found in combination with TENORM when conducting risk assessments. The Committee noted additionally that, although a uniform national standard for TENORM exposure is desirable in order to achieve complete protection from TENORM- related hazards, development of such a standard probably is not possible for a variety of reasons. The reasons included the major differences in physical and chemical characteristics of different TENORM materials. The Committee felt that EPA should concentrate its efforts on individual sources of TENORM. Additional suggestions were made on the use of stylized, yet reasonably realistic, risk assessment scenarios, and the acceptable use of exposure periods truncated over time.

2.3 EPA's aproach to TENORM

Responding to the NAS report, EPA agreed to implement the Academy's recommendations, also taking into consideration recommendations made previously by the EPA's own Science Advisory Board (SAB).

EPA had previously undertaken efforts to characterize and assess the risks from all TENORM industry wastes and products in a single draft "scoping document" . The last draft of that scoping report was studied and evaluated in 1994 by its SAB. The SAB's review report (1994) made a number of recommendations which would require substantial efforts to update information on the characterization of each TENORM source, methods by which it was generated, and how risk assessments of the materials' hazards were carried out. EPA took steps to respond to its Science Advisory Board recommendations in the ensuing years, further revising the draft scoping report on TENORM wastes while attempting to obtain voluntary industry and State data. These efforts were generally unsuccessful in obtaining the levels of information needed. Additionally, information came to light that other

industries not originally characterized in the previous draft reports had TENORM problems.

EPA re-evaluated its approach to TENORM after reviewing the NAS study and decided that covering all forms of TENORM in a single scoping report could not be accomplished with its available resources and time. Accordingly, a four pronged approach was decided upon, and this was described in the report back to Congress (2000). First, the agency would address only one commodity/TENORM industry waste at a time in a series of sequential technical reports. Similar to an effort undertaken previously on non-radioactive components of mining waste by another part of the Agency, the sequential reports would allow EPA to concentrate its activities and better characterize each source.

Secondly, while developing these reports, field studies of existing sites could be conducted. The field studies would help provide a nation-wide view by identifying problems with the waste or product, finding out where it was being produced or where it had been left unreclaimed by previous operators in years gone by. Also, field and laboratory studies would be used to characterize the waste or product chemically and physically, and more realistically assess the risks of the TENORM source.

Thirdly, the Agency plans to develop and provide education and guidance. This would be for the purpose of preventing accumulation of TENORM wastes and products and unnecessary radiation exposure to workers and members of the public. It would also hopefully provide for a means for more safely and economically preventing, cleaning up and disposing of TENORM; this includes existing or “legacy” waste sites which may not have a current owner or industry operator planning on reclaiming the site.

Lastly, EPA will work to establish partnerships with other organizations and stakeholders to enhance data sharing, and avoid duplication of efforts. This includes States and localities, indigenous populations, other Federal agencies, industry and environmental groups, and international entities, as well as the general public. By taking this step, EPA can gauge the need and type of solutions to risks/hazards of each TENORM substance, whether a waste or a product.

2.4 Uranium mining TENORM

To assess the risks and impacts of uranium mining TENORM, the first TENORM waste to be studied separately under this approach, EPA is developing a technical report that will provide a “state of the industry” overview, the risks presented by the resulting waste streams, remediation and reclamation efforts by stakeholders including costs and methods, and the results of case studies. The intended audience is anyone impacted by uranium mining and these wastes.

Waste materials which are, or could be classified as TENORM from uranium mining include conventional surface and underground mining overburden, interburden, unreclaimed sub-economic ores, "barren" rock, and drill cuttings. Radioactive waste waters, evaporation pond sludges and evaporites from the in-situ leaching process were classified by NRC as mining waste (and hence TENORM) beginning in 1995, but decisions by the Commission in 2000 put them back under the NRC's regulatory control; appeals by the National Mining Association have been made to rescind that policy. Due to uncertainty related to the future outcome of that situation and a recommendation by the EPA's SAB, information on the in-situ mining process and waste characteristics will be discussed in the EPA technical report.

Uranium mills and mill tailings impoundments are regulated by the NRC and its Agreement States. Many of the physical and chemical processes used at conventional uranium mills are the same as those which extract uranium at *in situ* leaching operations. While the tailings are not considered TENORM in the United States, this phase of the uranium fuel cycle will also be described in the technical report because radiation protection standards for the tailings impoundments may have applicability to waste disposal for uranium mine TENORM wastes. Additionally, the NRC has decided to allow mill operators to dispose of wastes other than tailings in the impoundments, which is a possible disposal route for some currently unreclaimed uranium mine TENORM.

Although uranium and thorium are termed "source material" by the AEA and thus overseen by the NRC, the radium content and radon emanations of uranium mining TENORM do bring it into EPA's purview. As well, the NRC does not have the authority to oversee mining (other than the above ground facilities at *in-situ* leaching facilities), nor does it have the remediation responsibilities for past facilities. Cleanup actions taken for radium contamination will also generally encompass the uranium and thorium at a site. Additionally, efforts are now being explored on means by which NRC may delegate its uranium and thorium authority to EPA, the States, and other agencies for site remediation, licensing or other purposes (see below).

While the EPA report is being prepared as a technical document, some topics will be presented in a manner which will allow the general public to better understand the discussion. The draft report will be provided for stakeholder review and meetings with affected parties, plus peer review of the written material. After revision and issuance as a final report, it is expected that the study will be used as the basis for decisions on next steps for providing health standards or guidance for radiation exposure, economic and safe waste disposal practices, community and industry education, or regulations for this waste if needed.

Supporting the development of the report, and providing more data for input to the risk assessment, the Agency has commenced a number of field and laboratory

projects. These projects expand knowledge of uranium mining TENORM's physical and chemical characteristics, as well as its uses and disposal. This research also fulfills certain recommendations regarding TENORM made to EPA by the National Academy of Sciences. In addition, the field projects establish additional contacts between EPA, the uranium industry, governmental and Tribal organizations, and individuals who manage or oversee the reclamation of uranium mining TENORM wastes.

This is a significant challenge with approximately 4000 abandoned uranium mines nationally in more than 10 U.S. States (both eastern and western). The environments and physical/chemical conditions can vary significantly from site to site. EPA contract studies developed estimates that perhaps only 50 percent of these mines' wastes have been reclaimed nationally. However, many more unreported mines and exploration site wastes most likely have never been included in these counts.

Perhaps one of the most significant problems with uranium mining TENORM from conventional mines is that large quantities of unreclaimed spoil materials are readily accessible for use in building or house construction. During recent demolitions of houses on Tribal lands in the American Southwest (Sowder et al., 2001), EPA staff found that the sand and gravels had been used for making foundations and cement, and finer grained materials had been used for wall stucco; larger mineral bearing rocks often were used as ornamental or building stone. A previous EPA report to Congress on uranium mine wastes (EPA, 1983) found approximately 500 structures (buildings, houses) had used this material for construction. Although the information had been shared with State agencies, and risk assessments conducted in that study showed that radiation exposure scenario to be of the highest risk, no follow-up study has been as yet identified as whether these sites had been remediated. It is also unknown how many additional sites may have been constructed since that time. It is hoped that the new technical report will focus more attention on this radiation hazard.

2.5 TENORM coordination and juridiction

There is a considerable effort currently within the United States to coordinate activities, reviews and project funding involving TENORM. Several Federal agencies, along with an observer from State government, have established a coordination committee to work cooperatively on the development of radiation standards, to exchange views and information regarding ongoing radiation programs, and coordinate studies on important radiation issues. This committee, called the Interagency Steering Committee on Radiation Standards (ISCORS), is comprised of representatives of 15 agencies with various responsibilities for radiation protection in the U.S. Subcommittees of the ISCORS have worked on TENORM problems, including the Federal Guidance Subcommittee, the (TE)NORM Subcommittee, and the Sewage Sludge and Ash Subcommittee.

The latter ISCORS committee has been conducting a study over the last 3 years to determine the quantities and types of radionuclides present nationally in sewage sludge and ash in order to determine whether additional controls need to be placed on the discharge of radionuclides into the sanitary sewer systems of the U.S., or limits on the use of sewage sludge and ash as a soil amendment, or other means of its disposal. To accomplish this effort, voluntary samples were obtained and analyzed from 350 publicly owned treatment plants. Computer modeling is being conducted to examine doses from this material, and draft guidelines have been prepared for the owners of the treatment plants on what to do if they find radiation present. TENORM radionuclides such as radium are an area of concern in this study because industrial facilities, including water treatment plants, may be discharging waste concentrations into the sewers which may become reconcentrated in the sewage sludge and ash.

As mentioned previously, the NRC currently does not regulate uranium and thorium in materials when the concentrations are less than 500 parts per million. The Commission issued a directive to its staff dated March 9, 2000, to initiate interactions with EPA, OSHA, and the States to explore the best approach to delineate the responsibilities of the NRC and those agencies with regard to low activity source material which included TENORM. In doing so, a Jurisdictional Working Group was established to evaluate existing and planned regulation of such materials and assess the willingness of those agencies to assume responsibilities for certain levels of source material and other material. That effort is still ongoing, but could provide a means for the delegation of authority from the NRC to EPA and other agencies to complete oversight of the TENORM radionuclides of uranium, thorium, and their daughter products.

One problem area for radiation control is the recycling and disposal of TENORM contaminated scrap metals. EPA is currently conducting a pilot project with the U.S. Customs Service intended to detect and determine how much radioactive material is entering the U.S. via the port of New Orleans, where the majority of all imported scrap metal is received in the country. Radioactivity detectors are installed on grapples for offloading from ships. The State of North Carolina has also implemented a monitoring program similar to EPA's. Large scintillating crystals are attached to grapples that offload scrap from ships. The Recycle Subcommittee of ISCORS is following this program and will be seeking opportunities to combine data with the EPA study. In the meantime, consultations are occurring between the Federal agencies over procedures for handling radioactive materials that may arrive in the country in scrap metal. Data from this study may inform the Federal government if there is a problem and if there is a need for government regulation.

3 OCCURRENCES OF TENORM IN THE U.S.

Previous studies by EPA (1993) estimated that over 1 billion tons of TENORM is generated annually in the United States. Much of this is high volume, low radioactivity materials, primarily generated by the mining industry. However, notable exceptions are the high radiation levels found in some oil field scales of Michigan (up to several hundred thousand picocuries/gram; low tens of thousands of Becquerels), and water treatment plant wastes in areas with high radium levels in groundwater (sludges and resin filters with maximum radium contamination up to tens of thousands picocuries per gram; 10 or less Becquerels).

A wide variety of U.S. industries have wastes and products known to contain TENORM, most of which are the same as those known to concentrate this radiation elsewhere in the world (coal ash, phosphate mining, phosphate fertilizers and potash, petroleum, geothermal energy, uranium/thorium/vanadium mining/processing, zircon and titanium use, rare earths. Many times the problem is derived from imported material (e.g., heavy mineral sands, aluminum ore) which is less expensive than domestic raw materials or ores. Sometimes the problem is the use of ground water contaminated with small amounts of radionuclides (e.g., drinking water treatment plants, paper and pulp factories). More often, the problem may be concentration of radionuclides contemporaneously with the geological deposition of one or more other minerals. In the U.S., certain deposits of gold, silver, copper, and phosphate in various locations have also been mined economically for uranium or thorium; this may result in radioactive contamination at the originating mine, in ground water, or at the processing plant. Other minerals known to have associations with TENORM radioactivity include: tin, barite, fluorite, molybdenum, tungsten, and some gemstones including opal and epidote. Work will be continuing in the U.S. to evaluate the levels of radiation, their geographic occurrence, and potential hazards over the next several years, and determine the best means of radiation protection for the public and environment.

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