Washington Internships for Students of Engineering

The American Nuclear Society

Controlling the Release of Solid Material from NRC Licensed Facilities – Should There be a "Clearance Rule"?

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July 20, 2001

Introduction

Nuclear technology benefits society in many ways. Radioactive materials are used medicine, research, product development and power production. Twenty percent of the electricity generated in the U.S. comes from nuclear power. This energy source, which causes no direct greenhouse gas emissions, is projected to decline in coming years as old plants close and none are built to replace them. Production cost (fuel plus operations and maintenance) in 1999 at U.S. nuclear power plants averaged 1.83 cents per kilowatt-hour, lower than coal-fired plants at 2.07 cents per kWh, oil-fired plants at 3.18 cents per kWh, and natural gas plants at 3.52 cents per kWh.[1] If nuclear power is economically viable environmentally responsible, then what is holding the industry to only 20% of the U.S. energy market? It is certain that concern over radioactive waste and its detrimental effects to the population and environment is a major factor in limiting the nuclear industry.

There are many different types and levels of radioactive waste generated using nuclear technology. Radioactive wastes range from highly radioactive and dangerous spent fuel, to the minute levels of contamination on the clothing of personnel and tools used daily to work on equipment in the facilities. With many radioactive isotopes having half-lives in the order of thousands of years, society must take responsibility now to ensure the health and safety of the public in the future. The U.S. has plans to store the highly radioactive spent fuel waste at a deep geological repository. Currently, Yucca Mountain is under study as a possible site. However, materials with very low levels of radioactive contamination compose the majority of the radioactive waste in the U.S. (85% by volume).[2]

In the nuclear industry, materials used in day to day operations need to be evaluated for radioactive contamination prior to release from control. This includes all items that have potential for contamination, for example: workers, clothing, shoes, vehicles, tools, equipment, consumables, etc. These are the items that end up in low level waste facilities if the criteria for release are not met. The term “clearance” is used when referring to the removal of items or materials that may contain residual levels of radioactive materials within authorized practices from any further control of any kind.[3]

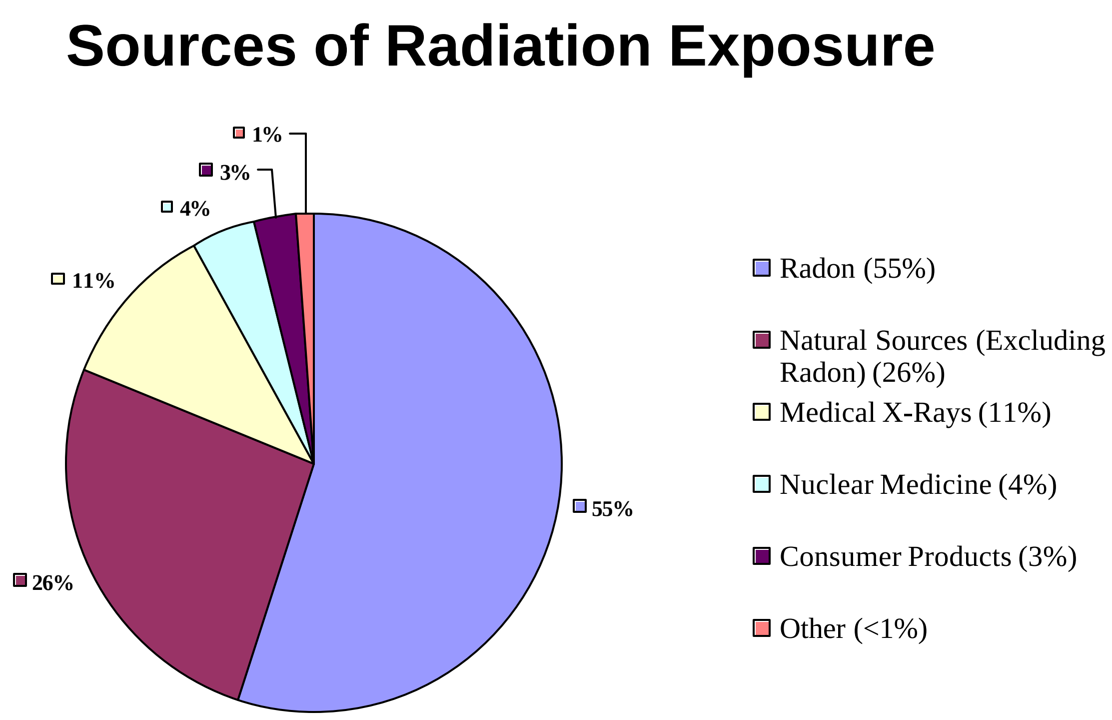
Upon the decommissioning of nuclear facilities, the materials (steel, concrete, and soil for example) that comprise a nuclear facility need to be evaluated. In order to release material from nuclear facilities for reuse or disposal, it is necessary to survey materials to evaluate their radiation exposure risk. The important question when clearing materials with the potential for low levels of radioactive contamination is: “How much radioactive contamination is acceptable?” In other words, what is the acceptable level of radioactive contamination on or in the items or materials released from nuclear facilities?

The Nuclear Regulatory Commission (NRC) is currently examining its approach for controlling the release of solid materials at NRC licensed facilities (nuclear power plants, research reactors, and medical applications) as published in Issues Paper in the Federal Register (64 FR 35090) on June 30, 1999. The purpose of the paper was to encourage public involvement in discussion about issues associated with alternative courses of action for control of solid materials at licensed facilities that have very low amounts of, or no, radioactivity.[4] To provide opportunity for public input, the NRC held a series of public meetings during the fall of 1999 at four locations around the country, as announced in the Federal Register Notice. Written and electronic comments on the paper were also accepted and posted on the NRC web-page.

On August 18, 2000, the NRC decided to: (1) defer a final decision on whether to proceed with rulemaking, (2) proceed with a National Academies study on possible alternatives for release of slightly contaminated materials, (3) continue the development of a technical information base necessary to support a policy decision in this area, and (4) stay informed of international initiatives in this area, related Environmental Protection Agency (EPA) and Department of State (DOS) activities, and potential for import and trade issues.[5] The scope of this paper is limited to the decision as to whether or not to proceed with the rulemaking process - Should there be a national clearance rule for the release of solid material?

Background

Understanding of radiation and its health effects is essential in the discussion of a clearance rule. The following is a brief summary of radiation and its effects on human health. Figure 1 shows the sources of radiation exposure to the average person in the U.S.[6] The average person is exposed to about 360 mrem/year. Of the 360 mrem/year, 55% of the exposure is from radon and <0.01% comes from the nuclear fuel cycle. Natural sources of radiation include the ingestion of potassium found in food for example. Potassium contributes about 15 mrem/year to women and 19 mrem/year to men.[7] The naturally occurring uranium and radium found in the



clays of which bricks are made may add up to 10 mrem/year. Cosmic radiation accounting for 8% of total exposure can vary greatly depending on where one lives. Cosmic radiation doubles every 6,600ft of altitude. For example, people living in Denver, CO receive 70 mrem/year more than those who live at sea level due not only to thinner atmosphere, but also the higher concentrations of natural radioactive materials.[8]

Reports of negative health effects due to radiation exposure began to arise shortly after the discovery of X rays and naturally occurring radioactive materials around the turn of the century. Initial radiation protection efforts were established to minimize direct physical symptoms while the latent effects of radiation exposure became increasingly apparent.[9] Bone cancers in workers using paint containing radium confirmed that a relationship between radiation exposure and negative health effects does exist.[10] While high doses and dose rates of radiation have been shown to have negative health effects, the health effects of very low levels (near background levels) of radiation are still argued. One reason for the continuing controversy is that the sample size required to make an argument is not available. In order to establish a relationship between the radiation dose of one mrem/year and the risk of getting cancer would require ten million subjects who had received that dose.[11] Another obvious problem with establishing the probability of producing cancer by low levels of radiation is it impossible to distinguish cancers produced by low levels of radiation from cancers produced by other phenomena.

Even though it is understood that radiation exposure is unavoidable and perhaps even beneficial at low levels, radiation regulatory agencies such as the International Commission on Radiological Protection (ICRP) and the U.S. National Council on Radiation Protection and Measurements (NCRP) have endorsed the "linear no-threshold" approach and the philosophy that radiation exposure should be kept "*A*s *L*ow *A*s *R*easonably *A*chievable" (ALARA).

However, if an individual wants to lower his or her radiation exposure, there are many ways to do so. One of the most practical ways of reducing radiation exposure is limiting the radon exposure. Radon averages two hundred mrem/year but can range up to several thousand mrem/year. Having a radon detector installed in the basement and circulating the air inside or using a fan with a positive ion exchanger. Naturally occurring radioactive materials are also present in tobacco. Smokers of two packs a day are estimated to receive an extra 1300 mrem/year. This is over three times the average exposure.

In order to insure the health and safety of the public, the NRC creates and enforces regulations to maintain safe and "*A*s *L*ow *A*s *R*easonably *A*chievable" (ALARA) dose levels to individual members of the public. Title 10 of the Code of Federal Regulations Part 20 contains dose limits for individual members of the public that nuclear facilities are responsible for maintaining. One hundred mrem per year is the primary dose limit allowed to any individual member of the public from licensed activity (10CFR20.1301). There are lower dose levels allowed (25 mrem per year) for individual members of the public after a facility has been decommissioned.

In order to ensure compliance with dose limits for individual members of the public, NRC licensees must measure the radiation levels in unrestricted and controlled areas and in the effluents (gases and liquids) released from the facility. 10CFR20 includes Table 2 Appendix B which puts specific limits on gaseous and liquid effluents released from NRC licensed facilities. Table 2 was derived from analysis and experimentation to ensure that the TEDE to the individual likely to receive the highest dose from licensed operation does not exceed the annual dose limit. The analysis behind Table 2 involves consideration of how the effluents disperse and applying mathematical models to the scenario. Table 2 simplifies the requirements to the licensee thus helping to ensure the health and safety of the public while minimizing the costs in doing so.

The NRC also requires licensees to survey materials at the facilities to evaluate their radiation exposure risk to the public. The current decisions on the clearance of materials with the potential for low levels of radioactive contamination are made using a variety of criteria such as Regulatory Guide 1.86 and/or on a case by case basis as specified in 10 CFR 20.2002. The exact criteria used by the licensee depend on the individual license agreement and vary from place to place.

Regulatory Guide 1.86 entitled: "Termination of Operating Licenses for Nuclear Reactors" is a guide, established for the decommissioning of nuclear facilities, that is used by many licensees as a guide for the clearance of workers, tools and equipment on a daily basis. Table I of Regulatory Guide 1.86 entitled "Acceptable Surface Contamination Levels," was established for examining materials at decommissioned nuclear facilities for *surface* contamination. There are no guidelines for the release of solid materials with *volumetric* contamination, meaning that they have become contaminated throughout the volume of the material. The clearance levels in Regulatory Guide 1.86 are based on the detection capabilities of measurement technologies, and are referred to as "technology-based" clearance levels. These existing guidelines only apply to exposure from individual radionuclides and do not limit the cumulative exposure that might be of concern when more than one radionuclide is present. While this provides reasonable assurance that elevated levels of radioactive material are not being released, the lack of established logical criteria for controlling solid materials does result in inconsistent release levels.

A national dose based clearance standard for the release of solid material with potential surface and/or volumetric contamination from NRC licensed facilities would: 1) reduce costs and overall risks with release of materials; 2) provide consistent release levels from state to state and internationally; 3) and allow more timely and consistent cleanup of contaminated sites.

Stake Holders

Following the publication of the Issues Paper in the Federal Register (64 FR 35090) on June 30, 1999, four public meetings were held in the fall of 1999 at four locations around the country and written and electronic comments on the paper were also accepted and posted on the NRC web-page. "Attendance at the four meetings included representatives from scrap and recycling companies; steel and cement manufacturers; sanitary waste facilities; the U.S. Environmental Protections Agency (EPA); U.S. Department of Energy (DOE); US Department of State (DOS); State agencies; Tribal governments; NRC licensees and licensee organizations; and the Health Physics Society."[12] The comments of the stake holders are summarized below as taken from NRC document SECY-00-0070.[13]

Oppose Release of Materials

1) Cement industry representatives oppose the recycling of concrete from NRC licensed facilities for the same reasons the steel industry opposes the recycling of steel from licensed facilities (potential loss of business due to public perception of danger).[1]
2) Metals and scrap industry representatives generally opposed the release of solid materials from NRC licensed facilities. These commenters noted that if consumers refused to buy products because of concerns over the presence of radioactivity, there

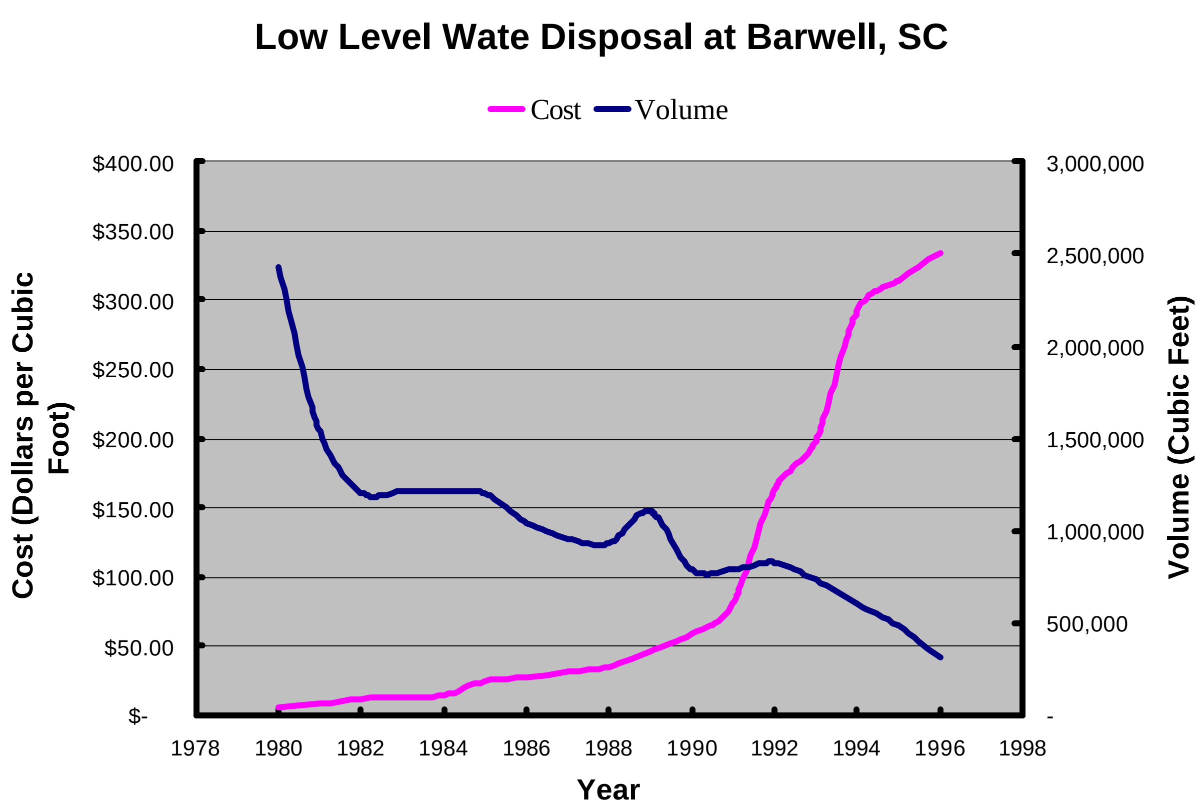
[1] The Issues paper noted that the dose from use of recycled coal ash in concrete block as permitted by the EPA can be about 3 percent of natural background (about 10 mrem/year). "Fly ash" is the ash resulting from the burning of coal which is classified as a "technically enhanced naturally occurring material." In 1983, the EPA issued guidelines requiring the purchase of cement containing fly ash in both government and private sectors. The guidelines were a response to a directive from Congress to provide some relief to companies that generate fly ash in coal generated electricity with regard to this high volume, low hazard waste.

could be sever economic impact on their industries even if the calculated dose or health risks were low.[14]

3) Citizen groups and individuals in general opposed the release of solid materials from NRC licensed facilities due to the belief that no dose above background is acceptable, no matter how small.

In Favor of a Standard

1) Licensees (Universities, medical facilities, fuel cycle facilities, and nuclear power plants) These groups generally recommended that NRC adopt the American National Standards Institutes' (ANSI) consensus standard N13.12. The licensee could benefit economically (Figure 1) from a clearance rule that is consistent with international



standards by either recycling or disposing of material in a landfill (rather than disposal at a low level waste disposal site). Figure 1 shows the rising cost and decreasing volume of low level waste at Chem Nuclear System's Barwell, SC facility.[15] From 1980 to 1996, the cost of disposing of one cubic foot of waste rose from $6.00 to $333.77.

2) Landfill operators are run by private companies and a rule may have an impact on siting of future landfills. These commenters were in favor of a rule based on 1mrem/year with concentration limits similar to those in 10CFR20 for effluent release.

3) Health Physics Society and individuals Recommended that NRC adopt the American National Standards Institutes' (ANSI) consensus standard N13.12. N13.12 is a voluntary consensus standard that is protective of the public health consistent with the National Council on Radiation Protection and international scientific organizations.

4) States and State organizations One mrem/year was suggested as the dose criteria for a rule.

Current Activities

Due to the diversity of public views expressed on this issue, the process by which discussions move forward is equally as important as the technical basis for such a rulemaking. The NRC has chosen a deliberate process soliciting public comment early in order to enhance the acceptability of a standard. The National Academies (NAS) was awarded a contract by the Nuclear Regulatory Commission for the study of possible alternatives for the release of slightly contaminated materials. The purpose of the eighteen month study is to obtain expert input from an impartial and credible source. There are two broad alternatives that the NRC could pursue:

1) Do not conduct a rulemaking and continue with current practices with one of the following options:
   a) Continue using Regulatory Guide 1.86 or other case-specific criteria.
   b) Update existing guidance.
2) Develop a proposed rule involving the completion of database on dose an cost analyses and on survey methods and completion of a Generic Environmental Impact Statement (GEIS) and Regulatory Impact Analysis (RIA).

In addition to the NAS study, the NRC is collecting information on inventories of materials at facilities, potential pathways of radiation exposure and the doses, associated costs, and various possible survey methods. The NRC is also considering the ongoing international activities concerning clearance. Radionuclide concentrations and conditions for clearance currently vary from country to country. Differences in the criteria by which material is cleared may adversely affect international trade. The European Commission is establishing new standards for clearance on the dose basis of one mrem/year (which is considered a "trivial dose").[16] The International Atomic Energy Agency and the European Commission are directing countries to conform to international standards. If U.S. standards differ from international standards, import/export problems could result.

Not only are there international implications to an NRC rulemaking, but there are at least four other Federal Agencies that would likely be impacted: The Department of Energy (DOE); Department of Transportation (DOT); Department of Defense (DOD); and the Department of Treasury (Customs Service). Under the Atomic Energy Act, the EPA is responsible for setting environmental standards. The Radiation Protection Program of the EPA includes a Clean Materials Program to ensure a national supply of clean metal for general use. After studying each of the potential ways in which metal can become contaminated with radioactivity, the EPA determined that orphaned sources and imports of foreign metals are the most likely origins of contaminated steel in this country and need to be the first priorities. Orphan sources are: "Sealed radioactive sources that fall out of established control mechanisms required by radiation protection regulations. These devices are used in manufacturing and for medical purposes. An example of how radiation can enter the metal supply is when a radiation source becomes mixed with scrap metal during remodeling at a manufacturing plant."[17] The DOE and DOD have materials with low levels of radioactive contamination that are not under NRC control. However, the DOD and DOE will likely establish orders and regulations in conformance with the NRC.

Recommendation

Nuclear technology provides many benefits to society. Operators of Nuclear facilities that provide these benefits must move materials and equipment in and out of these facilities on a routine basis. Also, the facilities themselves must be dismantled and either disposed of, reused, of recycled. In order to protect the health and safety of the public, the Nuclear Regulatory Commission currently regulates the release of potentially contaminated solid materials through a combination of regulations, guidance, and case by case exception. Although this approach ensures the protection of the public, the lack of established logical criteria for controlling the release of solid materials does result in inconsistent release levels.

In 1999 , the Health Physics Society published ANSI N13.12, “Surface and Volume Radioactivity Standards for Clearance.” This voluntary consensus standard is consistent with the philosophy and approach of the International Atomic Energy Agency. Public Law 104-113 “National Technology Transfer Act of 1995” and the U.S. Office of Management and Budget Circular A-119, “Federal Participation in the Development and Use of Voluntary Consensus Standards” both intend for Regulatory Agencies to adopt voluntary consensus standards. However, the NRC public participatory process is very important in building confidence in the rulemaking process and should be followed.

Setting any environmental standard requires weighing the costs verses the benefits and this is how the NRC should proceed. For example, the arsenic found in the drinking water of the U.S. is held to a maximum level of 0.05 milligrams per liter.[18] The EPA is looking at lowering the arsenic level in drinking water. It is understood that arsenic is detrimental to the health of the public, yet a certain amount of it is allowed. Weighing the cost of removing more arsenic verses the health benefit to the public sets the amount of arsenic allowed in the drinking water. The final decision to reduce the arsenic level will largely be based on the cost of implementing this new criterion versus the health benefit to the citizens of the U.S.

The NRC should proceed with a rulemaking setting criteria based on the one mrem/year dose standard that is consistent with international regulations.

[1] Utility Data Institute; *1999 Production Cost Data Bases*

[2] Moeller, Dade W. Environmental Health. Harvard University Press; 1992 page 118.

[3] International Atomic Energy Agency (IAEA), Vienna; *Principles for the Exemption of Radiation Sources and Practices from Regulatory Control*, Safety Series No. 89 (IAEA 1988)

[4] Nuclear Regulatory Commission; *Release of Solid Materials as Licensed Facilities: Issues Paper, Scoping Process for Environmental Issues, and Notice of Public Meetings.* Federal Register (Volume 64, Number 125): June 30, 1999.

[5] Nuclear Regulatory Commission; *Quarterly Report on Progress Made on Pertinent Issues Related to Control of Solid Materials, January – March 2001*

[6] National Council on Radiation Protection Report number 93

[7] Moeller, Dade W. Environmental Health. Harvard University Press; 1992 page 186.

[8] Nuclear Regulatory Commission; *Below Regulatory Concern – A guide to the Nuclear Regulatory Commission's policy on the exemption of very low-level radioactive materials, wastes and practices* NUREG/BR-0157.

[9] Moeller, Dade W. Environmental Health. Harvard University Press; 1992 page 208.

[10] Eisenbud, M. *Environment, Technology, and Health: Human Ecology in Historical Perspective.* New York: New York University Press. 1978.

[11] Moeller, Dade W. Environmental Health. Harvard University Press; 1992 page 183.

[12] Nuclear Regulatory Commission; *Summary and Categorization of Public Comments on the Control of Solid Materials.* NUREG/CR-6682, September, 2000.

[13] Nuclear Regulatory Commission; *Control of Solid Materials: Results of Public Meetings, Status of Technical Analyses, and Recommendations for Proceeding* . SECY-00-0070, March 23, 2000.

[14] Nuclear Regulatory Commission; *Summary and Categorization of Public Comments on the Control of Solid Materials.* NUREG/CR-6682, September, 2000.

[15] Chem Nuclear Systems, Inc. Prices for Barwell LLW Disposal Site. Columbia, SC

[16] *Laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation.* The Council of the European Union, Council Directive 96/29/EURATOM. May 13, 1996.

[17] Environmental Protection Agency. Clean Materials Program (retrieved from the World Wide Web: http://www.epa.gov/radiation/cleanmetals/).

[18] The Code of Federal Regulations, Title 40-Protection of Environment, Part 141.11b, 2001.