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Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for Maywood, New Jersey

U.S. Department of Energy

0489-0613.1

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II
26 FEDERAL PLAZA, RM. 747
NEW YORK, NY 10278

EMERGENCY & REMEDIAL RESPONSE DIVISION - FAX # 8-264-6192

FACSIMILE REQUEST AND COVER SHEET

TO:

Susan Cange /Bill/Dan

OFFICE/PHONE NO.

FAX #: 615-576-0956

FROM: Jeff Gratz

OFFICE/PHONE NO. 212-264-6667

FAX #: 212-264-6607

DATE: 9/14/93

COMMENTS: Attached is the letter forwarding the Maywood dispute to the SEC - we faxed a copy to J. LaGrone.

NUMBER OF PAGES TO FOLLOW COVER SHEET 2

(PLEASE NUMBER ALL PAGES, BEFORE FAXING)

108482

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY 1993 SEP 17 PM 2:28

REGION II

JACOB K. JAVITS FEDERAL BUILDING

NEW YORK, NEW YORK 10278-0012

SEP 14 1993

Mr. William J. Muszynski, P.E.
Acting Regional Administrator
U.S. Environmental Protection Agency
Region II
Jacob K. Javits Federal Building
New York, New York 10278

Mr. Joe LaGrone
Manager, Oak Ridge Operations
U.S. Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831

Re: Cleanup Levels for Radionuclide Contamination at the Maywood Chemical Company Superfund Site, Maywood, New Jersey

Dear Members of the Senior Executive Committee:

The purpose of this letter is to notify you as the members of the Senior Executive Committee (SEC) that the Dispute Resolution Committee (Mr. Les Price of the Department of Energy and myself) and our respective staffs at EPA Region II and DOE's Oak Ridge Field Office have been unable to come to an agreement regarding cleanup levels for radionuclide contamination in soils at the Maywood Chemical Company Superfund Site, pursuant to Section XV of the Federal Facility Agreement (FFA) entered into by EPA and DOE for the Maywood Site. Pursuant to Section XV of the FFA, I am forwarding the attached Statement of Dispute to the SEC for resolution. In accordance with the FFA, if the SEC cannot unanimously resolve the dispute within 21 days of receipt of this letter, the EPA Regional Administrator shall issue a written position on the dispute. Also pursuant to the FFA, DOE may, within 21 days of the issuance of the Regional Administrator's position, issue a written notice elevating the dispute to the Administrator of EPA for final resolution. In the event that DOE elects not to elevate the dispute to the EPA Administrator, DOE shall be deemed to have agreed with the EPA Regional Administrator's position on the dispute.

Both our staffs have worked very closely together in a diligent attempt to resolve this dispute. In the course of the dispute to date, EPA and DOE have conducted site-specific evaluations in an attempt to come to agreement on the protectiveness of the cleanup levels proposed by DOE. That attempt has been unsuccessful. DOE provided a significant amount of site-specific information in support of its argument. Unfortunately we were not able to agree on two assumptions (future land use and future building construction details).

Beyond our disagreement on the assumptions that DOE used to show that the proposed cleanup criteria would be protective at Maywood, DOE and EPA disagree on the criteria which are used to define "protectiveness." It is EPA's position that under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP), remediation goals are required to be developed for known or suspected carcinogens at an acceptable exposure level of between 10^{-4} and 10^{-6}. DOE contends that for radionuclides, an acceptable dose is 100 millirems per year, a standard recognized by the International Commission on Radiological Protection and the National Academy of Science. While EPA agrees that this number is appropriate for subchronic exposure, we believe it is not protective when exposure is chronic - an important factor used to determine acceptable risk under CERCLA and the NCP. When chronic exposure is considered, 100 millirems per year dose falls outside of EPA's acceptable risk range.

It is my hope that the above issues on which EPA and DOE disagree, while difficult, can be resolved by the SEC. Mr. Price and myself note that both of you have expressed an interest that this dispute be quickly elevated further, to the EPA Administrator pursuant to the FFA, for final resolution if it becomes clear that the SEC members cannot come to an agreement. It is the mutual goal of EPA and DOE that remediation at the Maywood site begin as soon as possible.

I am transmitting a copy of this letter to you via FAX today.

Sincerely,

GP Pavlou

George Pavlou, Acting Director
Emergency and Remedial Response Division

Attachment

cc: L. Price, DOE-OR w/attach.
S. Cange, DOE-OR w/attach.
J. Wagoner, DOE-HQ w/attach.
B. Venner, NJDEPE w/attach.

JUN 2 1 1993

Mr. George Pavlou, Acting Director
Emergency & Remedial Response Division
U.S. Environmental Protection Agency
Region II
Jacob K. Javits Federal Building
New York, New York 10278

Mr. William M. Seay, Acting Director
Former Sites Restoration Division
U.S. Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831

Re: Cleanup Levels for Radionuclide Contamination at the Maywood Chemical Company Superfund Site, Maywood, New Jersey

Dear Members of the Dispute Resolution Committee:

The purpose of this letter is to notify the Dispute Resolution Committee (DRC) that respective project managers and immediate supervisors at EPA Region II and DOE's Oak Ridge Field Office have been unable to come to an agreement regarding cleanup levels for radionuclide contamination at the Maywood Chemical Company Superfund Site, as required by Section XV of the Federal Facility Agreement (FFA) entered into by EPA and DOE for the Maywood Site. Pursuant to Section XV of the FFA, a 30-day informal dispute resolution period which began with your receipt on May 21, 1993 of our letter to you, expires today. The Parties to the FFA have not been able to informally resolve the cleanup level issue. Therefore, this letter serves as EPA's formal written statement of dispute, thereby elevating the dispute to the DRC for resolution.

Background

On April 20, 1993, DOE submitted to EPA the draft final Feasibility Study (FS) and Proposed Plan for the Maywood Site. In the FS and Proposed Plan, DOE identifies the following remedial action objectives for residual soil contamination:

5 pCi/g averaged over the first 15 centimeters (cm) below the surface, and

15 pCi/g averaged over 15 cm thick layers more than 15 cm below the surface.

These numbers were developed to support the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). Title I of UMTRCA authorized standards for disposal (Subpart A of 40 CFR Part 192) and cleanup (Subpart B) of uranium mill tailings at sites designated under Section 102 (a)(1) of the Act. Those sites are a closed set chosen in 1979 and cannot be added to. They include "vicinity" sites at which cleanup of specified off-site properties for unrestricted use is authorized. **DOE contends that, while these cleanup levels are not directly applicable to the Maywood Site, they are relevant and appropriate as well as protective of human health.**

EPA Position

EPA has two objections concerning the use of these cleanup criteria at the Maywood Site. First, we contend that the 15 pCi/g limit is not an applicable or relevant and appropriate standard (ARAR) for Maywood and, based on site conditions at Maywood, the limit provides inadequate assurance that a safe level of health protection will be met. Second, we contend that the 5 pCi/g limit, while not applicable, is relevant and appropriate at the Maywood site at all soil depth levels and is protective of human health subject to confirmatory site-specific measurements.

1) The concentration criterion for subsurface soil in Subpart B of 40 CFR 192 (15 pCi/g of radium-226) is not a health-based standard. Thus, it should not be applied to situations in which a health-based standard is appropriate, or to situations that differ substantively from those for which it was derived. The basis for this criterion is documented in the materials accompanying the promulgation of Subpart B (see the preamble to the final rule in 48 FR 600 and accompanying Final Environmental Impact Statement (FEIS) on pages 134-137 and D-51 to D-52; and *Findings of an Ad Hoc Technical Group on Cleanup of Open Land Contaminated with Uranium Mill Tailings, EPA, 1981, Docket A-79-25*), and is summarized below.

   The criterion for subsurface soil was derived as a practical measurement tool for use in locating discrete caches of high activity tailings (typically 300-1000 pCi/g) that were deposited in subsurface locations at mill sites or at vicinity properties. The criterion for subsurface soil in Subpart B was originally proposed as 5 pCi/g (46 FR 2562). The final regulation was changed, not because the health basis was relaxed, but rather in order to reduce the cost to DOE of locating buried tailings - under the assumption that this would result in essentially the same degree of cleanup at the Title I sites as originally proposed under the 5 pCi/g criterion (48 FR 600 and FEIS page D-51). The use of a 15 pCi/g subsurface criterion allowed the DOE to use field measurements rather than laboratory analyses to determine when buried tailings had been detected. It is only appropriate for use as a cost-effective tool to locate radioactive waste in situations where contaminated subsurface materials are of high activity and are not expected to be significantly admixed with clean soil.

The 15 pCi/g subsurface criterion was not developed for situations where significant quantities of moderate or low activity materials are involved. Such is the case at the Maywood Site. Its use in such a circumstance would be inappropriate and would not satisfy the risk objectives achieved under Subpart B for uranium mill tailings.

2) The concentration limit for surface soil in Subpart B of 40 CFR 192 (5 pCi/g radium-226) is a health-based standard and can be reasonably applied as a relevant and appropriate requirement for radium-226 or combined radium-226 and radium-228. The relevant health risk for surface soil, external gamma exposure, provides the basis for this limit. (The basis is noted in the preamble to 48 FR 600 and is discussed in greater detail in the accompanying FEIS on pages 57, 111-112, and 134-137.) The concentration limit can be reasonably applied to subsurface soils as well. As discussed above, the criterion for subsurface soils in Subpart B was originally proposed as 5 pCi/g but was changed in the final regulation to 15 pCi/g. The 15 pCi/g criterion was not developed for situations such as at Maywood, where significant quantities of moderate to low activity materials exist in subsurface soil. The risk scenarios at the Maywood Site, however, are sufficiently similar to those in UMTRCA to warrant use of 5 pCi/g, the health-based standard.

The intent of the remedial objectives is to allow unrestricted access to the site either in the current or future use scenario. **It is EPA's position that the appropriate soil concentration criterion should be 5 pCi/g through all soil layers regardless of depth.** As an attachment we have included two technical papers which support our position: *Cleanup Standards for Radium Contaminated Soils*, Russell, John L. and Richardson, Allan C.B., Office of Radiation Programs, USEPA, presented in the Waste Management '92 Symposium, University of Arizona, Tucson, March, 1992 and *Scientific and Public Issues Committee Position Statement: Radiation Standards For Site Cleanup and Restoration*, Kathren, R. et.al., Health Physics Society Newsletter, June, 1993.

Pursuant to Section XV of the FFA, the DRC has 21 days following receipt of all statements of position (or the expiration of the period provided for their submittal) to unanimously resolve this dispute and to issue a written decision. Upon receipt of this letter, DOE will have 30 days to submit a position paper after which the 21-day period will commence. I hope that we can come to an agreeable resolution of this issue within the above timeframe. If you have any questions, please call either of us, Jeff Gratz at (212) 264-6667 or Bob Wing at (212) 264-8670.

I am transmitting a copy of this letter to you via FAX today, June 21, 1993.

Sincerely,

Jeffrey Gratz, Project Manager
Federal Facilities Section

Robert J. Wing, Chief
Federal Facilities Section

Attachment

cc: S. Cange, DOE-OR w/attach
J. Wagoner, DOE-HQ w/attach
N. Marton, NJDEPE w/attach

108482

Presented at

Waste Management '92 Symposium
March 1-5, 1992
Tucson, Arizona

CLEANUP STANDARDS FOR RADIUM CONTAMINATED SOILS

John L. Russell and Allan C. B. Richardson
Office of Radiation Programs
U.S. Environmental Protection Agency

Abstract

In 1983 EPA promulgated standards for cleanup of uranium and thorium mill tailings at 40 CFR 192. These standards address a specific example of the cleanup of radium contamination. They have been used for the cleanup of radium-contaminated soils at other sites, primarily because they are the only related standards that exist. However, EPA advised caution at the time these standards were issued: "It should be noted that these standards in no way are intended to establish precedents for other situations or regulations involving similar environmental objectives, but with different economic and/or technological circumstances." (EPA 83) This paper assesses the suitability of these standards for use in the cleanup of contaminated soil at sites other than uranium or thorium mill tailings sites.

The 40 CFR 192 Cleanup Standards

The 40 CFR 192 rules specify two types of standards. The first addresses the disposal of uranium and thorium mill tailings, and are not discussed in this paper. The second addresses cleanup, and are the subject of this paper. They include limits for indoor radon concentrations and indoor gamma exposure rates for cleanup of buildings, as well as limits on radium concentrations in soil for cleanup of land. The former, those for indoor radon and gamma exposure, are health-based standards; while the latter, radium concentrations in soil, are technology-based standards, keyed to the sensitivity of radiation monitoring systems. For uranium tailings, the increased indoor radon concentrations and indoor gamma exposure rates were caused by placing tailings around buildings and houses. Radon is a decay product of radium and, since it is an inert gas, can move through soil and enter buildings above soil that is contaminated with radium. It was assumed at the time the 40 CFR 192 standards were promulgated that the indoor standards would be achieved by removing such tailings and replacing them with clean soils.

The 40 CFR 192 standards for soil specify a concentration limit of 5 pCi/g radium in the top 15 cm of soil and 15 pCi/g radium in any 15 cm thickness below the top 15 cm. The limit for the top layer was based on limiting external exposure rates to persons who may spend time on the land. Its purpose is to indicate when cleanup of thin surface layers of windblown tailings is necessary to provide adequate public health protection. Although this criterion provides adequate health protection for the situations it was developed to address, the value was selected with the limitations of field measurement equipment in mind, and the transient nature of windblown contamination situations.

The 15 pCi/g soil concentration limit is a technology-based standard. It is a practical measurement criterion for use in locating discrete quantities of tailings that were deposited or placed in subsurface locations at mill sites. These tailings deposits are generally limited in area and volume, with little or no mixing with adjacent soils, and have activities exceeding 100 pCi/g. Convenient measurement techniques for assaying radium activity in boreholes can not readily achieve a sensitivity better than 15 pCi/g in 15 cm layers. Since this is adequate for locating the edge of subsurface deposits of uranium mill tailings, it was selected as an appropriate standard for use at the tailings sites. Cleaning up deposits of tailings using this standard will leave at most only very small deposits that would not produce sufficient radon to cause a significant increase in indoor levels in a structure built over them.

The Relationship Between Indoor Radon and Radium in Soil

In this paper it is assumed that the goal of land cleanup around houses should be to meet the health protection standards of 40 CFR Part 192. These require limiting the average indoor radon concentration to 0.02 WL (4 pCi/l) including background, and restricting the indoor gamma exposure rate to 20 microR per hour above background at any location in a permanently occupiable structure. The technical objective, therefore, is to achieve those conditions in the soil around present (and potential) occupiable structures that will satisfy these indoor requirements.

The characteristics of the soil, the pressure differential between indoor air and the atmosphere, and the air exchange rate of the building itself are major factors that determine the buildup of indoor radon. For this paper, a model called RAETRAN (Ro 89) was used to examine the relationship between radium concentrations in soil and indoor radon concentrations in a house constructed over land contaminated with radium. In the RAETRAN estimates, the soil characteristics were varied, as were the radium concentrations in soil. The pressure differential and air exchange rates were held constant at values representing a new house constructed to meet current energy conservation guidelines.

RAETRAN predicts the movement of radon in soil by both diffusion and advection. Radon moves through soils along the path of least resistance. In many cases, particularly when subsoil is in its undisturbed natural state, cracks or volumes containing porous material create "channels" through which radon can move rapidly to entrance places in buildings. This movement of radon is caused by a difference in pressure and is called advective movement, or advection. The most advantageous situation (from the radon control perspective) is that of soils which have characteristics which force radon to move primarily through diffusion. Diffusion theory is based on the thermodynamic principle that radon will move to regions of lower radon concentration in its attempt to achieve equilibrium. Diffusion movement is advantageous for radon control since it takes longer for radon to move by diffusion than by advection. More radon will decay during this longer time period. While radon control is based primarily on replacing contaminated soil with clean soil, soil characteristics which assure that primary movement of radon through the clean soil layer is by diffusion provide additional protection.

RAETRAN estimates radon movement into houses directly through basement floors and through cracks in basement floors, e.g., the crack between the basement floor slab and the basement wall. (Ni 90, Ni 91) The source of the radon is the radium in the soil under and adjacent to the basement. In the model radon 1) diffuses through the basement slab into the house and 2) flows advectively from the soil through cracks and into the house. When the house parameters are held constant, the rate at which the radon flows is determined primarily by the characteristics of the soil. If soils retain significant fractions of water, radon will flow principally by diffusion. It is noted, however, that modeling radon movement through soils is a developing field. As more sophisticated models become available, detailed specifications of models may change.

The rate at which radon moves through the soil depends on the concentration of radon (from radium) in the soil and the soil characteristics: permeability, moisture content, and radon diffusion coefficient. A slow movement of radon is desirable, i.e., a low diffusion coefficient, to assure decay of most of the radon in the soil. The scientific basis for predicting the movement of radon through soil has been developed by Rogers, et.al. (Ro 84) and is widely used (NRC 89). This work forms the basis for RAETRAN (Ro 89).

In using the model it is important to recognize that there are two sources of radium: the radium in the clean fill (sandy clay loam) that replaces the contaminated soil in the excavated zone and the radium in the soil below or outside the excavated volume, i.e., the initially contaminated soil that has not been excavated. In making estimates of excavation depths the characteristics of both the replacement soil (the clean fill or backfill) and the existing, contaminated soil are used. An indoor radon concentration can be selected and, using RAETRAN, the concentration of radium in the underlying soil (which can be different for the replaced soil and the unexcavated soil) can be calculated for soils with various properties. The excavation depth can then be increased to assure that the radon moving through various soils and entering the house builds up to less than the indoor radon limit.

Our RAETRAN estimates (Hu 92) are based on:

- an indoor radon concentration of 2 pCi/l, to allow for other sources of radon,

- a house air exchange rate of 0.35/hour,

- an indoor pressure of -2.4 Pa,

- three different soils (clay loam, sandy clay loam, and loamy sand); however, the backfill soil is sandy clay loam for all cases,

- three different moisture contents in the soils (wet to dry: -0.1, -0.3, and -15.0 matric potentials),

- three different radium concentrations in the backfill (i.e., 1 pCi/g, 3 pCi/g, and 5 pCi/g), and

- other factors (as described in the accompanying paper by Hull and Nielson) (Hu 92).

A total of 81 different cases were modelled.

The major conclusion from the RAETRAN analysis is that for most soils, if not all, radon attenuation properties are insufficient to provide adequate protection from indoor radon that is produced by a homogenous mixture of radium at a concentration of 15 pCi/g radium in soil underlying a house. The zero excavation values for all cases fell between 5.8 and 10 pCi/g radium in soil, i.e., a concentration ~~greater than 5.8~~ to 10 pCi/g would require excavation of contaminated soil and replacement with cleaner (lower radium concentration) backfill.

From the model results it is evident that the properties of the underlying soil are most important in determining excavation depths (or in selecting radium concentration limits at a given depth). This is observed by comparing the allowable radium concentration in the underlying soil for an excavation depth of 2 meters. At long-term average matric potentials of -0.3 for both backfill and underlying soil, with backfill at 1.0 pCi/g radium, the difference in radium concentrations is more than an order of magnitude: 140 pCi/g for clay loam vs. 13 pCi/g for loamy sand. The difference is even greater if highly saturated soils are considered, again for a 2 meters backfill depth. At matric potentials of -0.1 for both backfill and underlying soil, with backfill at 1.0 pCi/g radium, the difference in radium concentrations limits in the underlying soil is 380 pCi/g for clay loam vs. 11 pCi/g for loamy sand. In both of these cases, the concentration limits for an underlying soil of sandy clay loam falls between the clay loam and the loamy sand.

The model results also indicate that, with sandy clay loam as the backfill for all cases, the radium concentration in the backfill greatly effects the excavation depth (or the acceptable radium concentration for a given depth). For example, the excavation depth increases from 2 meters to 3 meters as the radium concentration of the backfill is increased from 1 pCi/g to 5 pCi/g. Conversely, for a fixed excavation depth of 2 meters, the limiting radium concentration in the underlying soil decreases from 20 pCi/g to 10 pCi/g as the radium concentration in the backfill increases from 1 pCi/g to 5 pCi/g.

For cases where there is no contaminated material left beneath the excavated zone, the source of radon is primarily from the clean fill. Any of the soils having a radium concentration of less than about 5 pCi/g can be used to achieve the indoor radon limit. Therefore, the radium concentration of the backfill should not exceed 5 pCi/g which will assure that indoor radon will not exceed health protection limits (40 CFR 192).

Additional assessment is needed for cases where contaminated material is left under the clean fill. However, preliminary results indicate that radium concentrations as low as 10 pCi/g, combined with permeable backfill soils, may cause indoor radon levels that exceed the limit. Based on these preliminary results, removal of all radium contaminated soil is the preferred course. However, further assessment may lead to other options, especially if less permeable soils are used for backfill.

Based on the above estimates, with backfill soil directly beneath the floor slab, soil with a radium concentration of 5 pCi/g is consistent with the indoor radon limit. However, in all cases, the indoor radon limit will be exceeded if the soil concentration of radium is at or near the 15 pCi/g limit.

The Relationship Between Indoor Gamma Radiation Exposures and Radium in Soil

Examination of external exposure estimates indicates that indoor gamma radiation exposure may be very close to the limit specified in 40 CFR 192 when soil concentrations approach the 15 pCi/g limit for radium-226 and/or radium-228. Further work is needed to estimate external exposure levels in basement areas when a house is constructed in soil containing up to 15 pCi/g radium in soil.

The limit specified in 40 CFR Part 192 for gamma radiation levels is a structure applies at any location in the structure, whether occupied or not, and without limitation on the size of the area over which it applies. The standard is specified in terms of an ionization rate in air, and thus is not equivalent to dose to humans. This is to encourage direct measurement of radiation levels and ease implementation by avoiding the necessity of making numerous adjustments for occupancy, location of people within the building, and other factors.

Conclusions

The 40 CFR 192 soil concentration limits are technology-based standards that were developed specifically for application to the uranium and thorium tailings sites, and will generally not be suitable for application at other sites. However, since the 40 CFR 192 indoor radon and gamma limits are health-based standards, they can provide the basis for deciding what cleanup levels must be achieved in remedial actions involving radium-contaminated soil on which occupiable structures exist or may be constructed in the future.

The results of the model tests indicate that:

1. Based on estimates from the RAETRAN model for backfill soil directly beneath the floor slab, most soils with a radium concentration of 5 pCi/g or less will satisfy the indoor radon limit. However, in all cases, the indoor radon limit will be exceeded if the soil concentration of radium is at or near the 15 pCi/g limit.

2. For the case where essentially all soil contamination at a site is from a material that has elevated levels of radium, e.g., mill tailings, and if this contaminated soil has not been significantly mixed into adjacent uncontaminated soil, the 15 pCi/g radium limit will assure that only small quantities of contaminated soil will be left following remediation. For this case, the soil concentration limits in 40 CFR 192 provide a safe level of health protection.

3. For the case where soil contamination is from a large volume of low level radium-contaminated material, e.g., phosphogypsum wastes, or where higher concentration radium-contaminated soil has been significantly mixed into uncontaminated soils, the 15 pCi/g radium limit provides inadequate assurance that a safe level of health protection will be met.

108482

REFERENCES

EPA 83 U.S. Environmental Protection Agency, "Standards for Remedial Actions at Inactive Uranium Processing Sites," FEDERAL REGISTER, 48 FR 590, Jan 83.

Hu 92 Hull, H.B., and K.K. Nielson, "Relationship Between Radium Concentration Levels in Soil and Radon Transport Through Soils into Homes," Waste Management '92 Symposium, Univ Ariz, Tucson, 1992.

NRC 89 U.S. Nuclear Regulatory Commission, "Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers," Regulatory Guide 3.64, June 1989.

Ni 90 Nielson, K.K., and V.C. Rogers, "Radon Entry into Dwellings Through Concrete Floors," '90 Int'l Sym Rad & Rad Red Tech, U.S. Environmental Protection Agency, EPA/600/9-90/005c, Jan 90.

Ni 91 Nielson, K.K., R.B. Brown, and J.K. Otton, "Prototype Mapping of Radon Potentials in Florida," '91 Int'l Sym Rad & Rad Red Tech, U.S. Environmental Protection Agency, to be published, Apr 91.

Ro 84 Rogers, V.C., et.al., "Radon Attenuation Handbook for Uranium Mill Tailings Cover Design," NUREG/CR-3533, April 1984.

Ro 89 Rogers, V.C., K.K. Nielson, and G.B. Merrell, "Radon Generation, Adsorption, and Transport in Porous Media," U.S. Department of Energy, DOE/ER/60664-1, 1989.

COMMITTEE ACTIVITIES

Scientific and Public Issues Committee Position Statement: RADIATION STANDARDS FOR SITE CLEANUP AND RESTORATION

Ronald Kathren, Francis Massé, Kenneth Mossman, Genevieve Roessler, Keith Schiager

Executive Summary

The Health Physics Society* welcomes this opportunity to participate in the enhanced rulemaking process initiated by the Nuclear Regulatory Commission (NRC) for development of standards for site cleanup and restoration of decommissioned nuclear facilities. This participatory process is particularly important because of the tremendous impact these standards will have on this nation's economy for many years. We encourage regulatory agencies to establish radiation protection standards that are consistent with the recommendations of the scientific advisory organizations established specifically to make recommendations in this area.

Radiation protection standards should be based on health risks; they should be clearly related to quantities that can be measured, such as radiation exposure rates or radioactivity concentrations in soil, or on equipment or buildings. To ensure optimum protection of public health and environmental values, standards for site cleanup and restoration should be consistent with the fundamental principles recommended for all radiation protection activities, i.e. that radiation doses should be kept as low as reasonably achievable (ALARA), taking into account economic and social factors, with an upper limit to the dose that is likely to be received by any individual. The "economic and social factors" that should be taken into account include the health and environmental risks introduced by cleanup activities, e.g. the use of chemicals, construction activities, transportation, waste processing and disposal, as well as the direct financial costs.

We recognize and sympathize with the sincere apprehension many people have about health risks imposed by radiation exposures. This is also our primary concern, since our profession is dedicated to the prevention of unwarranted health risk due to radiation. We have no magic formula for allaying the fears of radiation, but we offer basic principles of protection, developed over several decades, that are appropriate for radiation and most other environmental hazards. Based on these principles, we provide several specific recommendations, followed by a discussion of the general considerations on which they are founded. Finally, we include comments on the four kinds of objectives described by the NRC in its paper "Issues for Discussion at Workshops" (1993).

SPECIFIC RECOMMENDATIONS

1. Remedial action should do more good than harm; the standards for site cleanup and restoration should be based on the principle of balancing the societal costs and risks of the cleanup against the societal benefits of actual radiological risk reduction, to assure that the net benefit to society is ~~maximized~~. Nonradiological risks, e.g., the use of chemicals for decontamination and the mechanical hazards of demolition and transportation activities, should be evaluated to assure that decisions are based on minimizing the total detriment, not just the radiological risk. The amounts spent specifically to achieve health benefits should be in the same range as is acceptable for any other health protection program that is undertaken voluntarily by the public. Expenditures for other categories of benefits, e.g., aesthetics, public good will, property valuation, etc., should be separately identified and justified.
2. For decisions on decommissioning strategies, the ALARA principle should be applied to the total radiation dose to society, including workers at the site as well as the general public. The standards must recognize the fact that the dose to site workers is part of the total dose to society and must be included in the balancing of risks and benefits. This requirement is specifically addressed by the ICRP, as follows: "The need for and extent of remedial action has to be judged by comparing the benefit of the reductions in dose with the detriment of the remedial work, including that due to doses incurred in the remedial work." (ICRP, 1991, ¶219) This recommendation is particularly relevant to decisions regarding immediate vs. deferred decommissioning, allowing for radioactive decay before final cleanup and restoration to a condition suitable for unrestricted use.
3. For unrestricted use of a restored site, we endorse the limit of 100 mrem (1 mSv) total effective dose equivalent (TEDE) to any member of the public in any one year from all nonmedical, manmade sources combined, recommended by both the ICRP (1991) and the NCRP (1993). For purposes of these recommendations, we use the term "total effective dose equivalent" (TEDE) adopted by the NRC (1991), which is the same quantity as the "effective dose" defined by the NCRP (1993); it is the sum over all tissues of the committed dose equivalent from penetrating external

[continued]

radiation and from intakes of radioactive materials. For site cleanup and restoration standards, we recommend that the dose limit be applied to all site-specific, nonoccupational sources, except indoor radon, including natural radionuclides whose concentrations have been enhanced by human activities.

4. We recommend that a compliance screening level of 25 mrem be applied to the mean annual TEDE to the critical population group, defined as the most highly exposed homogeneous group affected by the restored site. If the mean annual TEDE to the critical group is likely to exceed 25 mrem, an evaluation should be made to ensure that no individual is likely to receive an annual TEDE exceeding 100 mrem (1 mSv) from all site-specific, nonoccupational sources, excluding indoor radon.
5. Standards for site cleanup and restoration should include an assessment screening level below which further dose assessment is not required. The selection of this screening level is more a matter of practicality than of explicit risk assessment. For all site-specific, nonoccupational sources of radiation exposure, excluding indoor radon, we recommend an assessment screening level of 5 mrem annual mean TEDE to the critical group. We consider 5 mrem per year to be an appropriate screening level because it is unlikely that efforts to reduce doses below that level will do more good than harm.
6. For unrestricted release of sites containing ^{226}Ra, ^{232}Th or ^{228}Ra, we recommend a soil concentration limit of 5 pCi/g above the normal concentration for the region to prevent excessive ^{222}Rn or ^{220}Rn concentrations in indoor air. To limit the potential source for indoor radon adequately, the concentration should be averaged over an area of no less than 25 m^2 and no more than 100 m^2 and a soil depth of no less than 0.5 m and no more than 1 m. As a screening level for soil containing ^{226}Ra, ^{232}Th or ^{228}Ra, we recommend a soil concentration of 1 pCi/g above the normal concentration for the region, averaged over the same area and depth.
7. Standards for site cleanup and restoration should be based on probabilistic risk assessments designed to provide the best estimates of the distributions and uncertainties of doses that are likely to be received after restoration through the use of state-of-the-art, peer-reviewed and thoroughly documented calculational models and computer codes. The distribution of doses to the members of the public during and following decommissioning will be entirely different from the dose distributions resulting from operational emissions, which are limited by NRC and EPA regulations. During plant operation, most of the dose to the general public is rather uniformly distributed to relatively large numbers of the adjacent population. After decommissioning there will be essentially no dose to the population adjacent to the site. Only a very small segment of the population who reside or work on the restored site will receive any "public" dose. The hypothetical concept of a single "maximally exposed individual", for whom all exposure variables are assumed to be maximized simultaneously, should be replaced by calculations of the mean TEDE to the critical group, i.e., the homogeneous group receiving the highest doses from the restored site. Although modelling is required for calculating doses to critical groups and individuals, the input data to the models should be measurable, verifiable quantities, such as exposure rates or concentrations of radionuclides in environmental media.

GENERAL CONSIDERATIONS

Basis for Standards

Concern for environmental quality is justified by many considerations, including aesthetic values, maintaining ecological balance, conservation of resources and protection of human health. Of these diverse considerations, only the protection of human health requires radiological standards for decontamination or restoration. Since radiation cannot be seen, heard, felt or tasted, it cannot, of itself, produce any aesthetic degradation. For levels of environmental radiation or radioactivity that are within established standards for protection of human health, there is no anticipated adverse effect on ecological systems. Criteria for conservation of minerals, water or other natural resources are based on the preservation of a balanced ecosystem and on potential future use by humans, and only the health aspects of potential future use by humans is dependent on radiological standards. Consequently, there is no aesthetic, ecological or conservation basis for radiation protection standards different from those required to protect human health, and the economic and social factors that must be taken into account are comparable to those involved in any other health issue for which benefits are weighed against costs.

We concur with the recommendations of the ICRP (1991, ¶113) regarding criteria for intervention in existing situations:

"(a) The proposed intervention should do more good than harm, i.e., the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including social costs, of the intervention.

(b) The form, scale, and duration of the intervention should be optimized so that the net benefit of the reduction of dose, i.e., the benefit of the reduction in radiation detriment, less the detriment associated with the intervention, should be maximized."

We also subscribe to the ICRP recommendation that "the sum of the effective doses from each type of exposure"

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(i.e., occupational and public) "from a given source should be used in the optimisation procedures." (ICRP, 1991, ¶208)

Risk Assessment

Although it is possible to measure small radiation exposures and quantities of radioactivity, it is not possible to detect or measure the risk they are presumed to produce. Realistic assessment of the potential risk from residual radioactivity requires objective evaluation of the environmental transport of radionuclides and the potential for human exposure. The risk to society is calculated as the sum of the risks to its individual members and the TEDE is the quantity that best represents the biological risk to an individual from radiation exposure.

The collective societal dose, which is the sum of the TEDEs to all members of the public and to all workers, is an acceptable surrogate for the societal radiological risk and may be used in calculations for optimization when the collective dose is known. However, it must be recognized that the collective societal dose depends as much on demographics as it does on dosimetry. If the size and characteristics of the exposed population are unknown, there can be no valid estimate of societal dose. For site cleanup and restoration involving radionuclides that will exist for many decades or centuries, societal dose cannot be used as a surrogate for risk.

Almost all radiation risk coefficients originate as relative risks, i.e., the ratio of the observed to the expected number of cases in an exposed population. For most of the biological effects of radiation exposure, the relative risk model provides a somewhat better fit to the data than does the absolute risk model. If the only parameter that changes the societal dose is the size of the population, the average individual dose is the preferred measure of societal risk, since the societal relative risk is exactly equal to the average individual relative risk. Also, the upper limit to the societal relative risk is appropriately represented by the mean relative risk to the critical group. For this reason, we recommend that radiological standards for completion of site cleanup and restoration be expressed only as an individual-dose limit, evaluated in terms of the mean annual TEDE to the critical group.

If a dose is determined only by calculation, the principal input data should be quantities that are measurable and the model used for the calculation should be demonstrably reliable. Models for environmental transport and human or ecological exposures should be state-of-the-art, peer-reviewed and thoroughly documented. The modeling results should provide the best estimates of the distributions, including the uncertainties, of doses likely to be received by various population groups. The hypothetical concept of a single "maximally exposed individual," for whom all exposure variables are assumed to be maximized simultaneously, should be replaced by a calculation of the mean annual TEDE to a defined critical group.

Risk Management

Risk management decisions by regulatory agencies as well as by the affected licensees should be designed to maximize the benefit to the public. When applying the ALARA principle to doses below the mandatory individual dose limit, additional remedial actions should be justified by the likelihood for cost-effective risk avoidance on a case-by-case basis, not by setting a lower, arbitrary, regulatory dose limit. Expenditures of public funds should be justified by, and proportionate to, the societal risk that will be avoided by the proposed action. We do not believe that it is in the public interest to spend large amounts of public funds for remediation of a calculated public health detriment that is too small to be observed.

We recognize that there are societal benefits other than health that may be attained by site cleanup and restoration, e.g., property valuation and tax revenues, resource conservation, public acceptance, etc., and recommend that each of these be evaluated utilizing benefit/cost ratios that are considered acceptable for achieving similar public benefits in other situations. As health professionals, however, we offer recommendations only on remedial actions to obtain benefits that are health related. To the extent that site cleanup is expected to be justified by health benefits, we believe that it is appropriate to compare the anticipated results with the societal health benefits attainable by expenditures of resources in other ways, e.g., construction of hospitals, education of medical personnel, immunization of children, etc.

REVIEW OF ALTERNATIVES PROPOSED BY THE NRC

Several basic kinds of objectives or approaches have been suggested as the basis for radiological criteria for decommissioning (NRC, 1993). Each of the suggested objectives are discussed below, with recommendations for modifications or alternatives.

Risk Limit

Limitation of the risk to any individual is one of the essential components of radiological standards for site cleanup and restoration. For risks from radiation, we believe the limit should not be expressed as a risk value, but as an upper limit to the annual TEDE that is likely to be received by an individual at a restored site. We concur with the dose limit for individual members of the general public recommended by both the ICRP (1991) and the NCRP (1993) of 100 mrem TEDE in any year from all nonoccupational, nonmedical, manmade or site-specific sources combined, excluding indoor radon. We believe that compliance with this limit can best be demonstrated through the application of a compliance screening level of 25 mrem mean annual TEDE to the critical group. If this value is exceeded, an evaluation must be made to ensure that no individual is likely to receive a dose exceeding the individual dose limit.

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Risk Goal

We do not recommend the establishment of a standard that would define a level of residual risk to the public deemed trivial in all cases as the primary objective of decommissioning efforts. Our objection to this approach is twofold: First, there is no universally acceptable definition of trivial risk; even extremely small risks are considered by some people to be unacceptable if they perceive no personal benefit in taking the risk or if they believe the reason for taking the risk is immoral or unacceptable. Second, this approach would allow no balancing of societal benefits against societal costs of decommissioning, a fundamental principle of public health and radiation protection.

As a practical measure, we believe that the standards should include a lower limit for action. The ALARA principle implies that not only the management of risk, but also the assessment of risk, should be optimized. The effort expended in assessing a risk should not be disproportionate to the risk itself. If the ALARA principle could be applied quantitatively to all cases, the lower limit for action would be the point where the cost of a realistic risk assessment would exceed the potential benefit of any cleanup. For practical applications, however, a screening mechanism is needed to determine whether the potential benefit of decontamination or restoration is likely to justify a detailed risk assessment. We believe that a calculated mean TEDE of 5 mrem above normal background to the critical group in any one year would be appropriate as a screening level to determine whether any further assessment is likely to be beneficial and, therefore, necessary.

Best Available Technology

We recommend the use of best available technology (BAT) whenever it is compatible with the goal of optimizing total benefits. We do not believe that BAT should be the only criterion for site cleanup, regardless of cost or effectiveness, because inordinate expenditures could be required with little or no benefit. If this objective were to be used without other restrictions, it would imply that a site could be released for unrestricted use regardless of the remaining radioactivity or risk as long as the BAT had been used. We would certainly object to this implication on the basis that alternatives to unrestricted release should be considered if there was a significant residual risk after the application of the best available technology.

Return to Natural Background Levels

We do not consider the return to natural background levels to be ethically or scientifically justified as a primary objective for site cleanup and restoration. This approach is ethically unjustified since it involves no consideration of actual risk nor of cost. Furthermore, there is no scientific justification for such a standard since both "manmade" and "natural" radionuclides impose the same kind of risks.

Some proposed environmental restoration projects involve sites contaminated with small amounts of "manmade" radioactivity in soil that are to be returned to their "natural" state. The concept of "natural" should not be arbitrarily restricted to mean that only the original nuclides and concentrations are present. We are not so naive to believe that digging up some soil, burying it in containers in another location, and replacing it with soil from a third location is more "natural" than leaving small amounts of radioactivity in place! The important consideration should be the quantities and distributions of all radionuclides in the contaminated materials and the potential exposures to humans. Conditions that produce a distribution of radiation doses and risks to people within the normal range of natural background should be regarded as "natural."

The distribution and variability of radioactivity in the environment, and dose rates from natural sources, provides an excellent framework for establishing criteria for site cleanup and restoration. The recommended individual dose limit and the two recommended screening levels refer to doses in addition to the dose from natural background. The recommended compliance screening level of 25 mrem in any year is of approximately the same magnitude as the geographic variability of doses from natural background; it is comparable to the difference in annual dose likely to be experienced by a person who moves from one location to another. The recommended assessment screening level of 5 mrem in any year is approximately the same magnitude as the temporal variability of the dose from natural background at a single location; it is the difference in annual dose anyone is likely to experience without changing location. If the true background dose rate for the site was never established, the average background for the region should be used for comparison. However, it is immaterial whether any additional dose rate above the average background is contributed by natural or manmade radionuclides.

* The Health Physics Society, formed in 1956, is a scientific organization concerned with the protection of people and the environment from radiation. Today its membership numbers more than 6,400 and includes professionals representing all scientific and technical areas related to radiation protection drawn from academia, government, medical institutions, research laboratories and industry from 50 states, the District of Columbia, and Puerto Rico. The Society has more than 350 members in nearly 50 foreign countries. The Society is chartered in the United States as a nonprofit scientific organization, and as such is not affiliated with any governmental or industrial organization.

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