BEFORE THE U.S. NUCLEAR REGULATORY COMMISSION

PETITION BY UNION CARBIDE CORPORATION FOR PUBLIC RULE-MAKING

IN RE AMENDMENT OF CRITERIA 1, 5, 6, AND 10 OF APPENDIX A OF 10 C.F.R. PART 40

1 OF 2

BEFORE THE U.S. NUCLEAR REGULATORY COMMISSION

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IN RE AMENDMENT OF CRITERIA 1, 5, 6, AND 10 OF APPENDIX A OF 10 C.F.R. PART 40

Union Carbide Corporation ("Union Carbide") respectfully petitions the U.S. Nuclear Regulatory Commission ("NRC") to reconsider and revise Criteria 1, 5, 6, and 10 of Appendix A to 10 C.F.R. Part 40 (1981) on the basis of new information not available to the NRC when it promulgated these regulations on October 3, 1980 (45 Fed. Reg. 65531 et seq.).

I. INTEREST OF THE PETITIONER

Union Carbide is a New York corporation engaged in uranium exploration, milling and mining. It operates a uranium and vanadium milling facility at Uravan, Colorado and uranium milling facilities in Maybell, Colorado and Gas Hills, Wyoming.

The Colorado Department of Health ("CDH") is the licensing authority for the possession and use of source material for uranium milling and byproduct material in that state pursuant to an agreement entered into in 1968, and recently amended on May 10, 1982, under section 274 of the Atomic Energy Act of 1954, as amended ("AEA of 1954").[1] Union Carbide's Uravan uranium and vanadium milling facility is operated under a valid radioactive

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1 42 U.S.C. §2021

materials license designated SUA-673.[2] Its Maybell uranium milling facility is operated under a valid radioactive materials license designated 660-01S.[3]

In Wyoming, the NRC remains the licensing authority for the possession and use of source material for uranium milling and byproduct material, since Wyoming has not entered into an agreement with the NRC under section 274 of the AEA of 1954. Union Carbide's Gas Hills facility is, and has been, operated since 1960 under a valid radioactive materials license, designated SUA-648, issued originally by the Atomic Energy Commission ("AEC"), now the NRC.

The May 1982 amendment to the 1968 agreement between the CDH and the AEC came about as a result of the enactment of the Uranium Mill Tailings Radiation Control Act of 1978 ("UMTRCA")[4] which added a new definition of "byproduct material" to the AEA of 1954. "Byproduct material" was defined as the "tailings or wastes produced by the extraction or concentration of uranium or thorium from any

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2 The Uravan milling facility has been in existence since 1915. Union Carbide has operated it as a uranium and vanadium facility since 1957. Its original radioactive materials license was issued by the Atomic Energy Commission ("AEC").

3 The Maybell facility has been in existence since 1957 and has been operated by Union Carbide since that date, although not continously. Under its original license, issued by the AEC, conventional uranium milling operations were followed. Since 1976, a less convential uranium recovery process, i.e., heap leaching of low-grade uranium ores, has been authorized under its radioactive materials license.

4 Pub. L. No. 95-604, 92 Stat. 3021-3043 (1978).

ore processed primarily for its source material content."[5] In order to be authorized to control the licensing and regulation of such byproduct material, the CDH amended its radiation control regulations and requested the NRC to approve an amendment to the 1968 agreement.

The NRC approved the amendment to its agreement with Colorado because it determined that the State had adopted standards for the protection of public health, safety and the environment from radiation hazards associated with uranium mill byproduct material which meet the minimum standards[6] in Appendix A of 10 C.F.R. 40 established by the NRC pursuant to UMTRCA. Thus, Union Carbide's Uravan and Maybell uranium milling facilities must comply, at a minimum, with the NRC's national standards, even though the standards are imposed by CDH as the licensing authority in Colorado.

In Wyoming, since the NRC remains the regulatory agency for control of source and byproduct material, the standards in Appendix A for control of uranium mill tailings or waste are directly imposed upon Union Carbide's Gas Hills facility by the federal agency.

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5 Section 11e. of the AEA of 1954, 42 U.S.C. [illegible], as amended by Section 201 of UMTRCA, Pub. L. 95-604, §201, 92 Stat. 3033 (1978).

6 NRC regulations require that, "after November 8, 1981, in the licensing and regulation of byproduct material...or of any activity which results in the production of such byproduct material, an Agreement State shall require...compliance with standards which shall be adopted by the Agreement State...which are equivalent, to the extent practicable, or more stringent than, standards in Appendix A of 10 C.F.R. 40." 10 C.F.R. 150.31(b) (1981). As interpreted by the NRC (e.g., see letter of February 20, 1981 from John F. Ahearne, Chairman of the NRC to Governor Lamm of Colorado), NRC regulations constitute "minimum national standards."

10 C.F.R. 2.801 states that rulemaking may be initiated on the petition of "any ....interested person." As a member of the uranium mining and milling industry directly (i.e., in Wyoming) and indirectly (i.e., in Colorado) subject to the NRC requirements contained in Appendix A, Union Carbide qualifies as an "interested person."

II. REGULATION TO BE AMENDED

Union Carbide requests that Criteria 1, 5, 6, and 10 of Appendix A to 10 C.F.R. Part 40 be amended.

As a licensee of the NRC and an Agreement State,[7] Union Carbide must adhere to the criteria relating to the operation of uranium mills and the disposition of tailings or waste resulting from such milling activities contained in Appendix A (see 10 C.F.R. 40.31(h) and 10 C.F.R. 150.31).

It is Union Carbide's contention that compliance with amendments it proposes will protect public health, safety and the environment from radiation hazards associated with uranium milling byproduct material while significantly reducing Union Carbide's costs of compliance at its Uravan, Maybell, and Gas Hills mills.

III. PROPOSED LANGUAGE CHANGES AND SUPPORTING STATEMENTS

Criterion 1

Union Carbide proposes that the long-term isolation of tailings

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7 "Agreement State" means any state with which the NRC or the Atomic Energy Commission has entered into an effective agreement under subsection 274b of the AEA of 1954. For example, Colorado is an Agreement State.

and associated contaminants be defined as a 100-200 year period rather than a "thousands of years" period. Accordingly, Union Carbide proposes that this criterion read as follows:

> In selecting among alternative tailings disposal sites or judging the adequacy of existing tailings sites, the following site features, which will determine the extent to which a program meets the broad objective of isolating the tailings and associated contaminants from man and the environment during operations and for 100-200 years thereafter without ongoing active maintenance, shall be evaluated . . .

Testimony presented to the NRC during its consideration of mill tailings regulations, as well as before the CDH and the Environmental Improvement Board of the State of New Mexico in connection with their proposed regulations modelled on the NRC's uranium mill licensing requirements indicated that:

1. The selection of a "thousands of years" period is unreasonable;

2. Technology does not not exist to assure isolation of tailing for thousands of years;

3. Such requirement is both costly and speculative;

4. It is difficult, if not impossible, to design a reclamation plan for a tailings pile that will withstand erosion over a "thousands of years" period, a period of time for which meteorological data is nonexistent.

5. Tailings disposal should be based on a realistic period of time, such as 100-200 years;

6. Criterion 11, which requires ultimate federal or state title to, and control over, byproduct material and the land on which it is disposed, should be used as the desirable supplementary

measure it was intended to be. The "thousands of years" requirement tends to relieve the government of any responsibility for ultimate control; and

7. Finally, should an unexpected event occur which damages the cover, the funds required by Criterion 10 for long-term surveillance and control will be available to pay for any necessary repair.[8]

Additional testimony to the same effect was presented to the U.S. Environmental Protection Agency ("EPA") in response to its proposed disposal and cleanup standards for inactive uranium processing sites (46 Fed. Reg. 2556, January 9, 1981) and in hearings before the Procurement and Military Nuclear Systems Subcommittee of the Committee on Armed Services on June 24 and 25, 1981.[9]

Union Carbide therefore requests that the NRC reconsider its decision with regard to long-term isolation of tailings and determine that a 100-200 year period is sufficient and in accord with the requirements of UMTRCA.

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8 See comments by the American Mining Congress on the Draft Generic Environmental Impact Statement ("GEIS") on Uranium Milling (NUREG-0511) and on the Proposed Regulations on Criteria Relating to Uranium Mill Tailings and Construction of Major Plants, dated October 24, 1979; testimony of Dr. Robley Evans on June 11, 1981, before the Environmental Improvement Board of the State of New Mexico; comments of the Colorado Mining Association on the Colorado Department of Health's proposed revisions to its radiation regulations, dated June 5, 1981, June 17, 1981 and June 29, 1981; comments of the Uranium Environmental Subcommittee of the New Mexico Mining Association and Kerr-McGee Nuclear Corporation on proposed amendments to New Mexico's Radiation Protection Regulations, dated August 7, 1981.

Criterion 5

Union Carbide proposes that this criterion relating to groundwater restoration be revised. Union Carbide requests that the following sentences be deleted:

Where groundwater impacts are occurring at an existing site due to seepage, action shall be taken to alleviate conditions that lead to excessive seepage impacts and restore groundwater quality to its potential use before milling operations began to the maximum extent practicable. The specific seepage control and groundwater protection method, or combination of methods, to be used shall be worked out on a site-specific basis.

In their place, Union Carbide proposes the following:

Where excessive groundwater contamination that may cause present and future harm to human health and the environment is occurring at an existing site due to seepage of radioisotopes and other toxic materials into groundwater, corrective action shall be taken to clean up groundwater and alleviate conditions that may lead to such contamination to the maximum extent practicable. The specific seepage control and groundwater protection method or combination of methods to be used shall be worked out on a site-specific basis. In evaluating the method(s) to be used, consideration should be given to the current use of the groundwater, naturally-occurring characteristics of the groundwater, potential use of the groundwater based on needs of the community, size of the aquifer, and availability of other drinking water sources, and the practicability of restoration. In determining potential use of groundwater, any applicable state aquifer designation, water quality standard or water quality criteria shall be considered.

As presently written, Criterion 5 attempts to distinguish existing from new sources. For new sources, seepage may not result

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9 See comments of Dr. Robley Evans to EPA, dated May 27, 1981, EPA Docket No. A-79-25; testimony of Robert G. Beverly, Director, Environmental [Affairs], Mining and Metals Division, Union Carbide Corporation on behalf of the American Mining Congress on EPA's Proposed Disposal and Clean-up Standards for Inactive Uranium Processing Sites, dated May 14, 1981; "Uranium Ore Residues: Potential Hazards and Disposition," Ninety-Seventh Congress, 1st Session, Hearings Before the Procurement and Military Nuclear Systems Subcommittee of the Committee on Armed Services, June 24 and 25, 1981, H.A.S.C. No. 97-14.

in deterioration of existing groundwater supplies "from their current or potential uses" and technical alternatives are provided to assure that such deterioration does not occur. For existing sites, if groundwater impacts occur because of seepage, Criterion 5 requires that groundwater quality must be restored to its "potential use before milling operations began to the maximum extent practicable." Site-specific seepage control and groundwater protection methods are to be developed, but no guidance is given concerning the standards to be used in developing such site-specific programs. As a result the distinction between groundwater control methods for new and existing sources is more apparent than real. Union Carbide's proposed language is intended to provide the missing guidance for existing sources.

Criterion 6

Union Carbide proposes deletion of Criterion 6, which requires a three meter cover over tailings or wastes to result in a calculated reduction in surface exhalation of radon emanating from the tailings or wastes to less than two picocuries per square meter per second. In its place, Union Carbide proposes the following:

> This criterion addresses tailings cover requirements and radiation control. Earth cover shall be placed over tailings or waste at the end of milling operations to prevent erosion over 100-200 years. A site-specific geo-technical evaluation shall be made to determine cover design requirements. The evaluation shall take into consideration climatic conditions and surface hydrology. The cover shall be designed to result in a calculated reduction in radon emanation from the covered tailings or waste areas to assure that concentrations of radon and other radioactive material concentrations beyond a small buffer zone of approximately 500 feet established around the covered areas do not exceed limits specified in Appendix B, Table II of 10 C.F.R. Part 20, excluding background. Habitable structures within the buffer zone shall be prohibited. If

non-soil materials are proposed to be used for cover material, it must be demonstrated that such materials will not crack or degrade by differential settlement, weathering or other mechanism over 100-200 years.

It is the objective of the NRC regulations to stabilize and control mill tailings in a safe and environmentally sound manner in order to minimize or eliminate radiation health hazards to the public. Union Carbide proposes deletion of a radon flux standard because radon flux from tailing piles has no direct health-related significance.[10] The health concern is radon daughter concentrations within inhabited buildings near tailings piles.[11] A cover designed in accordance with Union Carbide's proposal will reduce the radon emanation rate and, in turn, the potential for radon daughter build-up in nearby buildings. The buffer zone immediately around the covered tailings or waste piles within which habitable structures are probibited will further contribute to protection of people from any dangers associated with tailings. This protection will continue with governmental ownership of the covered tailings piles and buffer zone after completion of a licensee's remedial action program.

Union Carbide proposes that, beyond a small buffer zone, the concentration limits for radon and other radioactive materials specified in Appendix B, Table II of 10 C.F.R. Part 20 should be

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10 See Footnotes 7 and 8, supra.

11 See Kerr-McGee Nuclear Corporation v. Nuclear Regulatory Commission, No. 80-2043 and consolidated cases, slip. op. at 34 (10th Cir., March 17, 1982) and Petition for Rehearing for Appellant American Mining Congress at 8, (10th Cir., 1982).

used as the standard which a site-specific cover design must meet since these limits have already been recognized by the NRC as the standard which protects against potential radiation hazards resulting from licensed NRC activities.

Union Carbide's proposal deletes the requirement that direct gamma exposure from tailings or wastes be reduced to background levels. External gamma radiation originates almost entirely from the outer one foot of tailings[12] and will be easily shielded by an earth cover designed in accordance with the above proposal.

The present NRC prohibition on the use of mine waste or rock that contains elevated levels of radium in the earth cover is also excluded from Union Carbide's proposal. If Union Carbide's changes to Criterion 6 are accepted, the material to be used as cover will be one among many considerations evaluated in determining cover design requirements.

Union Carbide bases its request to change Criterion 6 on the documents cited in its discussion of proposed changes to Criterion 1, above[13]. In addition, Union Carbide requests that the June 30, 1982 Commingled Tailings Study prepared by the U.S. Department of Energy ("DOE") be considered by the NRC in response to this request to revise Criterion 6.

Criterion 6 is based on perceived risks to the public from exposure to mill tailings. As pointed out in the DOE Commingled

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12 See comments of Dr. Robley Evans to EPA, dated May 27, 1981, EPA Docket No. A-79-25.

13 See pages 5 and 6 and Footnotes 8 and 9, supra.

Tailings Study, in testimony before Congress, and in comments to the EPA, health risks to the public from exposure to radium and radon from uranium mill tailings should be compared with risks from exposure to other natural sources of radium, radon and their daughters as well as to other risks commonly accepted by the public[14]. If such comparisons are made, it is clear that the health risks to the public associated with uranium mill tailings have been greatly overestimated.[15]

Union Carbide requests that Criterion 6 be revised so that cost-effective remedial actions are based on a realistic assessment of the health hazard to the public which uranium mill tailings may pose. Union Carbide believes that its proposal will insure that mill tailings are controlled in a safe manner and that people and the environment are protected from radiation hazards associated with tailings disposal.

Criterion 10

Criterion 10 imposes on each mill operator a charge to cover the cost of long-term surveillance. The total charge must be such that "with an assumed 1 per cent annual real interest rate, the collected funds will yield interest in an amount sufficient to cover the annual costs of site surveillance."

Union Carbide proposes that an assumed 2 percent annual real

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[14] See Footnote 9, supra.

[15] See Petition for Rehearing of Appellant American Mining Congress, American Mining Congress v. Nuclear Regulatory Commission, No. 80-2271 (10th Cir. 1982).

interest rate be used instead of a 1 per cent annual real interest rate.

Comments provided to the Colorado Department of Health by the Colorado Mining Association[16] in connection with its proposed radiation regulations indicated that "a 2% annual real interest rate is a more accurate reflection of the historic earning power of investments."[17]

Union Carbide therefore requests that the more accurate percentage spread between inflation and interest rates be used.

IV. GROUNDS FOR REQUESTED ACTION

Specific statements in support of Union Carbide's proposed changes have been provided in Part III of this Petition. This Part summarizes, in a more general way, the grounds on which Union Carbide bases its request for changes to Criteria 1, 5, 6, and 10 of Appendix A.

1. As authorized and required by UMTRCA, the NRC adopted its uranium milling and mill tailings regulations on October 3, 1980.[18] These regulations include Appendix A. As its introduction makes clear, the Appendix "establishes technical, financial, ownership, and long-term site surveillance criteria relating to the siting, operation, decontamination, decommissioning,

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16 Comments of June 5, 1981 and June 17, 1981.

17 Comments of June 5, 1982, page 8.

18 45 Fed. Reg. 65531.

and reclamation of [uranium or thorium] mills and tailings or waste systems and sites at which such mills and systems are located."

2. In order for Agreement States, that had previously assumed authority for regulation of the possession and use of source material in conjunction with uranium or thorium milling pursuant to Section 274 of the AEA of 1954,[19] to be authorized to continue the licensing and regulation of mill tailings (now that UMTRCA had given jurisdiction to the NRC), the NRC's 1980 regulations required Agreement States, in turn, to require compliance by their licensees with the requirements of Appendix A of 10 CFR 40.[20]

3. Colorado and New Mexico (Agreement States) held public hearings on June 17, 1981 and June 11-13, 1981, respectively, and solicited public comments as part of their own rule-making procedures so that they could adopt regulatory programs "equivalent, to the extent practicable, or more stringent than, standards in Appendix A of 10 CFR 40."[21] As a result, additional testimony and evidence have been elicited which were not available to the NRC in the consideration of its own regulations. Union Carbide requests that the NRC reconsider its regulatory program in light of the following documents, which are attached to and incorporated by reference into, this petition:

a. Colorado Mining Association comments on the Colorado

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19 42 U.S.C. §2021.

20 See 10 C.F.R. 150.31 (1981).

21 Id.

Department of Health's proposed revisions to its radiation control regulations, dated June 5, June 17, and June 29, 1981.

b. Comments of the Uranium Environmental Subcommittee of the New Mexico Mining Association and Kerr-McGee Nuclear Corporation on amendments to New Mexico's radiation protection regulations, dated August 7, 1981.

c. Testimony of Dr. Robley D. Evans before the New Mexico Environmental Improvement Board on proposed amendments to New Mexico's radiation protection regulations, dated June 11, 1981.

d. Analysis, including revised language, of the eleven criteria proposed to be added to New Mexico's Radiation Protection Regulations by the State's Environmental Improvement Division, dated August 5, 1981.

5. In addition to comments prepared in response to rule-making by Agreement States, more recent comments on mill tailings regulations have been presented to the EPA in response to its proposed standard for inactive uranium processing sites. Testimony on NRC's mill tailings regulations were the focus of a House Subcommittee hearing in 1981 and, most recently, this past August, after completion by the DOE of its report on the clean-up and cost of commingled tailings sites. Union Carbide requests that the NRC reconsider its regulatory program in light of the following documents which are attached to (unless otherwise specified), and incorporated by reference into, this petition:

a. Comments of Dr. Robley D. Evans to EPA, dated May 27, 1981, EPA Docket No. A-79-25;

b. Testimony of Warren K. Sinclair, President, National Council on Radiation Protection and Measurements, before the Procurement and Military Nuclear Systems Subcommittee of the Committee on Armed Services ("House Subcommittee"), 97th Congress, 2nd Session, August 18, 1982.

c. Testimony of Alphonso A. Topp, Jr., Chief, Radiation Protection Bureau, Environmental Improvement Division, Health and Environment Department, State of New Mexico, before the House Subcommittee, 97th Congress, 2nd Session, August 18, 1982.

d. Commingled Tailings Study, dated June 30, 1982, prepared by the U.S. Department of Energy (not attached).

e. Uranium Ore Residues: Potential Hazards and Disposition, 97th Congress, 1st Session, Hearings before the House Subcommittee, June 24 and 25, 1981, H.A.S.C. No. 97-14 (not attached);

f. Testimony of Robert G. Beverly, Director, Environmental [Affairs], Mining and Metals Division, Union Carbide Corporation on behalf of the American Mining Congress on the EPA's Proposed Disposal and Clean-up Standards for Inactive Uranium Processing Sites, dated May 14, 1981;

g. Testimony of George B. Rice, Vice-President, Kerr-McGee Corporation, on behalf of the American Mining Congress before the House Subcommittee, 97th Congress, 2nd Session, August 18, 1982.

6. The NRC regulations are based, in large measure, on the Final Generic Environmental Impact Statement on Uranium Milling ("Final GEIS"), NUREG - 0706. The Final GEIS contains estimates on

the number of uranium mills and the amount of mill tailings to be generated through the year 2000. These figures are inaccurate. A DOE mid-range projection of 180 gigawatts of increased nuclear generating capacity by the year 2000 was used in the 1980 Final GEIS to estimate U.S. uranium production necessary to meet estimated nuclear fuel needs through the year 2000. Since the Final GEIS was written, DOE projections have changed - downward. The March, 1982 report of DOE's Energy Information Service estimates that the gigawatts of nuclear power to be generated will be within the low range of 145 and the high range of 185. Because of additional cancellations and deferments of nuclear power plants since the information for that report was compiled, Union Carbide believes that DOE's low-range (145) is a more accurate replacement of the mid-range projection of 180 used in Final GEIS.

To generate 145 gigawatts of power, approximately 405,000 metric tons of U_3O_8 in yellowcake will be required by the year 2000. However, not all the U_3O_8 will be produced in the . S. Concomitantly, not all the tailings will accumulate in the U.S.

Imports accounted for approximately 10% of the enrichment feed for nuclear power plants in 1981. U.S. uranium enrichment policies are encouraging an increase in imports, and imports are indeed rising. Union Carbide estimates that net uranium imports will account for at least 20% of the U_3O_8 used in commercial reactors in the U.S. between 1979 and 2000 and that this fact should be considered by the NRC in estimating the accumulation of tailings between 1979 and 2000.[22] If so, the amount of uranium produced in the U.S. will be approximately 324,000 metric tons (80% of 405,000 metric tons of U_3O_8 needed). Given the estimate in the Final GEIS that 77% of all uranium will be produced by conventional milling, then future U.S. nuclear energy requirements served by such milling will result in the production in the U.S., of about 250,000 metric tons of U_3O_8, versus the Final GEIS estimate of 440,000 metric tons.

Because the estimates on the amount of U_3O_8 in the Final GEIS appear to be almost 1.8 times greater than present assessments indicate, the estimates of the amount of the mill tailings would also appear to be similarly overstated. Thus, the health effects attributable to uranium mill tailings, which are based in part on projected amounts of tailings, are also not accurate; they are over-estimated. Union Carbide requests that the NRC reconsider the health effect data on which is based its regulations in light of the significant change to domestic mill tailing projections.

7. The Final GEIS also fails to use the best available information on dose-response models, risk estimates and carcinogenic co-factors to calculate the benefits of radon emission controls and ignores the observed distribution of radon. Its cost estimates are also not accurate. Information on these points is provided in documents referenced in paragraphs 4 and 5, above.

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22 The effects of net uranium import-export balances were not included in the uranium demand projections in the Final GEIS. See 3-10.

These matters have also been brought to the NRC's attention in comments submitted by the American Mining Congress, among others, on the Final GEIS and proposed mill tailings regulations, in briefs filed by industry petitioners for review of the NRC's uranium mill licensing regulations in Kerr-McGee Nuclear Corporation v. Nuclear Regulatory Commission and consolidated cases (10th Cir.) and, most recently, in petitions for reconsideration filed by industry petitioners.[23] Union Carbide requests that the NRC reconsider its regulatory program in light of these documents.

8. Finally, the Introduction to Appendix A of 10 C.F.R. Part 40 states that "in many cases, flexibility is provided in the criteria to allow achieving an optimum tailings disposal program on a site-specific basis." Given the language of the criteria which follow, the site-specific flexibility promised by this sentence is not provided.

For the reasons enumerated in Parts I through IV above, Union Carbide requests that Criteria 1, 5, 6, and 10 of Appendix A of 10 C.F.R. Part 40 be reconsidered and revised.

Respectfully submitted,

UNION CARBIDE CORPORATION

By [signature]

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23 See in particular, Petition for Rehearing for Appellant American Mining Congress, in American Mining Congress, v. Nuclear Regulatory Commission, No. 80-2271, at 8 (10th Cir., 1982).

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APPENDIX A

TABLE OF DOCUMENTS[1]

1. Comments of the American Mining Congress ("AMC") on Draft GEIS on Uranium Milling (NUREG-0511) and on the Proposed Regulations on Criteria Relating to Uranium Mill Tailings and Construction of Major Plants, U.S. Nuclear Regulatory Commission ("NRC"), October 24, 1979.*

2. Final Generic Environmental Impact Statement on Uranium Milling ("GEIS"), NUREG-0706, NRC, September, 1980.*

3. Letter of February 20, 1981 from John F. Ahearne, Chairman of the NRC to Governor Lamm of Colorado.*

4. Comments of Dr. Robley D. Evans to the U.S. Environmental Protection Agency ("EPA") on Proposed Disposal and Clean-up Standards for Inactive Uranium Processing Sites, May 27, 1981, EPA Docket No. A-79-25.

5. Testimony of Robert G. Beverly, Director, Environmental [Affairs], Mining and Metals Division, Union Carbide Corporation on behalf of the AMC on EPA's Proposed Disposal and Clean-up Standards for Inactive Uranium Processing Sites, May 14, 1981, EPA Docket No. A-79-25.

6. Transcript of Testimony of Dr. Robley D. Evans on June 11, 1981 before the Environmental Improvement Board of the State of New Mexico.

7. Comments of the Colorado Mining Association on the Colorado Department of Health's proposed revisions to its Radiation Control Regulation, June 5, 1981, June 17, 1981, and June 29, 1981.

8. Uranium Ore Residues: Potential Hazards and Disposition, 97th Congress, 1st Session, Hearings before the Procurement and Military Nuclear Systems Subcommittee of the Committee on Armed Services ("House Subcommittee"), June 24 and 25, 1981, H.A.S.C. No. 97-14.*

9. Comments of the Uranium Environmental Subcommittee of the New Mexico Mining Association and Kerr-McGee Nuclear Corporation on proposed amendments to New Mexico's Radiation Protection Regulations, August 7, 1981.

[1] Documents not attached are marked with an asterisk. These documents are public records which should be within the NRC's possession.

10. Analysis, including revised language, of the eleven criteria proposed to be added to New Mexico's Radiation Protection Regulations by the State's Environmental Improvement Division, August 5, 1981.

11. Industry Petitioners' petitions and briefs for review of NRC's regulations governing licensing of uranium mills and uranium mill tailings in Kerr-McGee Nuclear Corporation v. Nuclear Regulatory Commission, No. 80-2043 and consolidated cases, 10th Cir.*

12. Petition for Rehearing of Appellant American Mining Congress, American Mining Congress v. Nuclear Regulatory Commission, No. 80-2271 (10th Cir. 1982).*

13. Commingled Tailings Study, U.S. Department of Energy, June 30, 1982.*

14. Testimony of Warren K. Sinclair, President, National Council on Radiation Protection and Measurements, before the House Subcommittee, 97th Congress, 2nd Session, August 18, 1982.

15. Testimony of Alphonso A. Topp, Jr., Chief, Radiation Protection Bureau, Environmental Improvement Division, Health and Environment Department, State of New Mexico, before the House Subcommittee, 97th Congress, 2nd Session, August 18, 1982.

16. Testimony of George B. Rice, Vice-President, Kerr-McGee Corporation, on behalf of the AMC before the House Subcommittee, 97th Congress, 2nd Session, August 18, 1982.

JUN 01 1981

ROBLEY D. EVANS
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May 27, 1981

Dr. William A. Mills, Director
Criteria and Standards Division (ANR-460)
Office of Radiation Programs
U. S. Environmental Protection Agency
Washington, D. C. 20460

Re: Remedial action for uranium processing sites (40CFR192)

Dear Bill:

Thanks for inviting my comments on several matters involved in EPA's proposed disposal and cleanup standards for Inactive Uranium Processing Sites (40CFR192) as published in FR 46, 2556-2563, January 9, 1981, (hereafter "FR81"), and in the EPA Criteria and Standards Division's Draft EIS for Remedial Action Standards for Inactive Uranium Processing Sites, EPA 520/4-80-011, December 1980, (hereafter "DEIS").

I do have several substantive constructive comments and a few minor ones to share with you.

Recall the remarks made concerning quite different health hazards by a water resource expert, Johns Hopkins' Professor Abel Wolman, in a 1960 JCAE hearing:

> "The development of criteria for the protection of health has invariably preceded full scientific understanding and acceptance... . The criteria have been eternally subject to reinterpretation, adjustment, and reframing as newer knowledge and experience were forthcoming."

My feeling is that there is sufficient new knowledge, not yet embodied in the DEIS or the FR81 to justify substantial adjustment of several of the standards proposed in FR81, paragraphs 192.12, and Tables A and B.

The Congressional mandate quoted in FR81 that "The Committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time." does not commit the EPA to propose standards which are overly severe in the reduction of radiation levels which are already so low that they are small compared with fluctuations in the natural background radiation. Rather, the Committee could have been asking that the balance be "done right" between perceived risks, benefits, and costs.

The guiding principle probably is that exposures should be kept as low as is reasonably achievable, economic and social considerations being taken into account ([illegible]). But where man-made exposures are significantly less than the variations in the natural background that has long been accepted as a normal fact of life, greatly increased expenditures of money and manpower, and possible serious harm to workers and the general public, in reducing the exposure further cannot be justified on any scientific basis.

My constructive comments on 11 topics may be abstracted as follows. These abstracts are then followed by detailed discussion of each topic. I am sorry I didn't have time to write a shorter commentary.

ABSTRACT

1. Radon Flux and Dispersion.

Table 4-2 lists theoretical radon decay product working levels (WL) at distances downwind from a nominal uranium pile whose total annual radon flux is taken as 10,000 Ci. The slow growth of WL with elapsed time downwind is not recognized. The tabulated WL values can be converted to intended Rn concentrations vs. distance from the pile.

Carefully measured radon values reported elsewhere for the piles in Salt Lake City, Grand Junction, Monticello and Durango show that no radon from these piles can be detected at distances beyond 1/4 to 1/2 mile from the pile. The theoretical values of radon concentration are found to clearly exceed the true values as measured in the field, especially within the first mile.

The dispersion model overestimates the radon concentrations, and the incorrect assumption of 50% decay product equilibrium further enhances the overestimate of exposure values in WL units. For the important close-in distances in the vicinity of 0.5 mile or less the combined overestimate can easily exceed a factor of 10. Therefore all of the estimates of attributable lung cancer for the "local" (0 to 6 miles), "regional" (6 to 50 miles), and "national" (beyond 50 miles) populations become invalid overestimates.

Those estimates totalled only 2 premature deaths per year from lung cancer attributable to radon released from all the 22 inactive uranium tailings piles without remedial action. This is to be compared with the death rate of 92,000 per year from lung cancer.

2. Radon Flux: Natural and Man-Made.

In round numbers, the average radium concentration of the earth's surface soils and rocks is about 1 pCi Ra/gram, or 2 Ci of Ra and 6 tons of uranium per square mile to a depth of 1 foot. This radium is a source which supplies atmospheric radon at a rate of about 1 pCi Rn/meter^2 · sec. Good grade uranium tailings piles, if dry and unstabilized, have a nominal flux of about 640 pCi Rn/meter^2 · sec. Therefore a handy rule of thumb is that the annual average radon flux from 1 acre of tailings is equal to that from 1 square mile of ordinary land, prairie, back yard, pasture, or desert.

The radon flux varies with rainfall and soil moisture content, freezing and thawing, fluctuations in barometric pressure and surface wind speed, plowing of fields, growth of crops, and other factors.

The 1966 to 1976 increase in the water level of the Great Salt Lake produced a decrease in radon emission in the Salt Lake City area which was 8 times the radon emission of the Salt Lake City uranium tailings pile. A change of 2% in the area of inland waters in the U. S. changes the national radon emission by an amount exceeding the total radon emission from all inactive uranium tailings piles.

The total radon released from all inactive unstabilized uranium tailings piles is a minute fraction of the variations produced by meteorological conditions and agriculture in the total radon released by natural processes from all land areas. The level of radon-decay-product exposure from unstabilized uranium tailings piles, at distances greater than 1/4 to 1/2 mile, is a minute fraction of the range of fluctuations of the natural background in the area. Under the ALARA principle no substantial action to reduce the exposure is warranted.

3. Lung Cancer Risk Factors.

The DEIS gives 4 different values for the lifetime absolute lung cancer risk factor, ranging from 3.0 to 11.1 per 10,000 person-WLM. These risk factors derive from unpublished data, never given peer review, and relate only to underground uranium miners. For the low-level exposure of the general population, not involved in underground labor, the recently published recommendation by 6 widely recognized senior specialists from 4 countries should be used. This is a lifetime risk with an upper bound of 1 per 10,000 WLM and with a lower bound which may include zero.

Adoption of 1×10^{-4} per WLM in place of values between 3.0 and 11.1 $\times 10^{-4}$ per WLM will reduce all estimated health effects (2 deaths per year, nationwide) by a factor somewhere between 3 and 10. Standards which were prepared on the older basis of risk can be relaxed to 3 to 10 times the proposals in FR81. This shift is in addition to, and in the same direction as, the corrections discussed earlier for radon-decay-product dispersion patterns.

4. Working Level and Working Level Months per Year.

The WLM unit of exposure is the product of exposure rate expressed as the radioactive concentration WL in the inhaled air, and the duration of the exposure M in units of the nominal 170-hour working month. Neither WL nor M has any dependence on air density or breathing rate. Therefore, for an exposure rate of 1 WL, extending uniformly for an entire year of 8760 hours, the exposure is 1 WL yr = 51.5 WLM. The relationship 1 WL yr = 27 WLM used in the DEIS on ground of differences in breathing rates is inaccurate. Differences in breathing rate is just one of many parameters which enter the estimation of the lung cancer risk factor for the general population from the basic data on uranium miners.

5. Fractional Occupancy Time.

The conversion factor between WL yr and WLM does depend on the duration of exposure time M measured in units of 170-hours. If the relevant exposure rate is in a workplace then the fractional occupancy factor would be 170/730 = 0.23, and 1 WL yr would equal 0.23 (51 WLM/yr) = 12 WLM.

Lifetime exposure in WLM will depend upon a variety of WL exposure rates experienced for various occupancy times in various work places, residences, shops, out-of-doors, etc. Regulatory guides on permissible WL in occupiable structures should recognize that the lifetime weighted average WL exposure rate is more important than the maximum WL experienced in a particular home or workplace. An average occupancy factor in the vicinity of 0.5 or less would seem reasonable. Then the conversion factor 1 WL yr = 27 WLM could be retained on a basis of fractional occupancy factor.

6. Indoor Radon Decay Product Concentration Standard.

With newer risk factors and cost effectiveness in view, an action level of 0.03 WL or 0.04 WL would involve less risk and much less implementation cost than had been associated with the 0.015 WL proposed in FR81.

7. Radon Flux from Stabilized Tailings Piles.

No radiobiological justification is known for the proposed radon flux limitation of 2 pCi Rn/m^2 · sec. It is unnecessary for "the protection of the public health, safety, and welfare, and the regulation of interstate commerce". Its implementation through massive translocations of earth and/or tailings would be very expensive, would be inflationary to the economy, and would be hazardous to the health of workers and the general public.

The mathematical justifications given in FR81 are distinctly inaccurate and hence the conclusions drawn from them are invalid.

The underlying purposes of PL 95-604 with respect to radon flux suppression would be fulfilled by procedures equivalent to providing a sturdy and durable cover of soil and vegetation adequate to prevent erosion and dispersion of tailings by extremes of weather, including rain, snow, ice, and windstorms, and by including a small buffer zone without habitable buildings in the area under Federal or State custody after completion of the remedial action program.

8. Gamma Radiation from Tailings Piles.

The gamma radiation offers no health hazard. Substantially all of the gamma radiation is self-absorbed within the pile. The external gamma radiation originates almost entirely from the outer one foot of tailings. It is easily absorbed by one or two feet of earth cover.

The attenuation of gamma radiation from the pile by overburden does not follow an exponential law, as would be the case for a point source. The concept of half-value-layer is not applicable to extended sources. Instead, the attenuation can be shown to follow a second-degree exponential integral. The actual attenuation by only 0.5 meters (20 inches) of soil is more than 5 times greater than given by the simple exponential transmission formula used in the DEIS. Some numerical examples are included in the detailed commentary. This bit of radiation physics can be corrected easily in any later version of the EIS. The FR81 is not affected.

9. Longevity of Disposal Standards.

The FR81 requests "... comments on whether 1000 years is the best choice". "Disposal" without any form of occasional surveillance is impracticable. "Management", not "disposal", is a more realistic plan.

Brief consideration of the changes which have t en place in recent centuries, from the Norman Conquest, to the fall . the Aztec civilization, and the founding of our Republic, suggest that it is impossible to predict even the state of the healing arts 100 years from now.

With Federal or State custody of the stabilized tailings sites planned under Section 202 of PL 95-604 after remedial action is completed, even 100 to 200 years seems a more than adequate time span.

10. Radium in Soil.

The 5 pCi Ra/g soil standard seems reasonable if it is intended to apply to cover materials near the surface. But the proposed rule needs to be clarified on the depth to which the "below 1 foot" rule applies. If it is any considerable depth then the radon flux at the surface could be 5 pCi $Rn/m^2 \cdot sec$, another reason for dropping the 2 pCi $Rn/m^2 \cdot sec$ concept.

11. Radium in Drinking Water.

Based on long-term epidemiological studies and on recent ICRP recommendations on annual limits of intake (ALI), raising the EPA drinking water standard for Ra-226 and Ra-228 from 5 pCi/liter to at least 30 pCi/liter can be shown to have a safety factor of at least 3 to 4 orders of magnitude with respect to the international radium MPBB standard of 0.1 μCi Ra. This can be shown without making any assumptions about the shape of the dose vs. response curve.

1. RADON FLUX AND DISPERSION

The estimate that without remedial action the radon from all the 22 inactive uranium tailings piles might cause about 2 premature lung cancer deaths per year in the nation (FR81, page 2558, column 1, and DEIS Tables 4-1 plus 4-6) should be compared with the national lung cancer death rate of 92,000 per year (Am. Cancer Soc. "Cancer Facts and Figures" 1978). As we shall see later the 2 lung cancer deaths per year is a substantial overestimate. But accepting the estimate provisionally for illustrative purposes, a remedial action which reduced the radon flux from a typical tailings pile by say a factor of about 20 would reduce this estimate to 0.1 lung cancer deaths per year (or 1 per 10 years) attributable to treated inactive uranium tailings. This is about one-millionth of the national lung cancer mortality, and even if overestimated is surely below any realistic level of significance.

The estimate of detriment due to radon from a tailings pile depends multiplicatively on three factors: (1) the radon flux from the pile, (2) the lateral dispersion of this radon in the environs, and (3) the lung cancer risk factor per working level month (WLM) for exposed persons.

The radon flux from a typical inactive and unstabilized tailings pile has often been taken as about 640 pCi Rn/$m^2 \cdot$sec (e.g., J.J. Swift et al. EPA-520/1-76-001, page 12) which will suffice here as a nominal "source term" although many piles have a smaller flux (DEIS, page 3-2).

The radial dispersion of this radon in the environs is treated in DEIS, chapter 4 and especially Table 4-2. This topic seems to me to require complete reconsideration and revision. Although no basis is given in the text, Table 4-2 lists calculated exposure in WL at 8 distances from 0.2 miles to 40 miles from the edge of a tailings pile which releases 10,000 Ci of radon per year (essentially equivalent to the Salt Lake City tailings pile as listed in Table 3-1 of the DEIS). The model used for this calculation can be reconstructed by plotting the tabulated values. These turn out to form a straight line with a slope of -1.7 on log-log paper (except for the point at 2 miles where the tabulated WL should read 0.0003 instead of 0.0004 WL). Therefore the radial dispersion model assumed by the author of this section was simply:

$$WL = 0.001\ D^{-1.7} \qquad (1)$$

where D is the distance in miles. There are several theoretical and experimental reasons for rejecting this model.

The text states that the model assumes a symmetrical wind pattern around the pile, with a constant speed of 6.5 mph. Also that a constant 50% equilibrium between radon and its decay products is assumed in outside air within 25 miles, and 70% equilibrium in outside and inside air at more than 25 miles.

Of course there are no decay products present when the radon emerges from the tailings pile. At a wind speed of 6.5 mph the travel time to a distance of 0.5 mile is 4.6 minutes. The build-up of decay products in young air has been shown to be well approximated by:

$$WL = 0.023\ t^{0.85} \qquad (2)$$

for 100 pCi Rn/liter, and time t from 1 to 40 minutes (Evans, "Engineers' Guide to the Elementary Behavior of Radon Daughters", Health Physics 17, 229-252 (1969)). Therefore in the 4.6 minute air at a distance of 0.5 mile the WL is less than 9% of equilibrium, rather than the 50% assumed in Table 4-2.

The WL values in Equation (1) are clearly incorrect. Because WL = 0.5 for 100 pCi Rn/liter air was assumed for all distances in Table 4-2, one WL corresponds to 200 pCi Rn/liter and we may rewrite Equation (1) in terms of radon concentration versus distance. Then:

$$Rn(pCi/liter) = 0.2\ D^{-1.7} \qquad (3)$$

This power function relationship is slower than an inverse square diminution of Rn with distance. It bears no resemblance to the exponential Gaussian-type dispersion formulas commonly employed in meteorological atmospheric pathway models (e.g., EPA-520/9-73-003-B, page A-2). No theoretical justification is found in DEIS for this power-function dispersion model.

Recall that there are good experimental values for the annual average Rn concentration as a function of distance from the tailings piles in Salt Lake City, Grand Junction, Monticello, and Durango, by S. D. Shearer Jr. and C. W. Sill between June 1967 and October 1968 (Health Physics 17, 77-88 (1969)), and for the Grand Junction pile between April 1974 and April 1975 by David L. Duncan et al. (EPA publication ORP/LV-77-1). For all sampling stations which were free from the overt local use of tailings, there was no measurable atmospheric radon from tailings at distances of 0.5 mile or more. Shearer and Sill wrote:

> "The tailings at Grand Junction are not affecting the atmospheric radon concentrations beyond a distance of 0.5 mile in the prevailing wind directions. At the other three study locations the effect of tailings is not observed at distances greater than one-quarter to one-half mile."

The measurements in 1974-1975 by Duncan et al. at Grand Junction, after that pile was restructured and stabilized in 1970, were in substantial agreement with the 1967-1968 measurements of Shearer and Sill at all the 12 off-pile sampling stations which were common to the two studies. Duncan et al. were unaware that at least 4 of their sampling stations were heavily contaminated, especially their station No. 10 at 645 E. 4th Ave. This led them to propose, erroneously, that at Grand Junction in the quadrant between 270 degrees (west) and 360 degrees (north) there was a "power curve relation" (meaning a straight line of unstated slope on log-log graph paper) between radon concentration and distance out to 1.5 miles. When the contaminated station No. 10 is excluded from the stations in the 270 to 360 degrees quadrant, their "power curve relation" disappears. Duncan et al. could not find any such relationship in the other 3 quadrants either. The radon concentration at distances of 0.5 mile or more from the center of the Grand Junction pile have the background value of about 0.8 $\pm$ 0.2 pCi Rn/liter.

Possibly the use of Equation (1) for the dispersion of radon from a tailings pile arose from this inaccuracy of interpretation in the report of Duncan et al. You will recall that I wrote to you on August 21, 1980 with full details of the effects of the several contaminated sampling stations at Grand Junction, and that you followed this up with a written request of September 24, 1980 to David Duncan requesting a response. However I have received nothing so far from him.

Equation (1), in its Rn concentration form as Equation (3), predicts a concentration of Rn from the Salt Lake City pile of 1.0 pCi Rn/liter at a distance of 0.4 mile, and 0.6 pCi Rn/liter at a distance of 0.5 mile from the pile. However in Salt Lake City the measured Rn concentration at stations 83 and 84, which are about 0.3 and 0.4 miles from the pile, have annual average concentrations of 0.43 and 0.39 pCi Rn/liter. These are not statistically different from the average background of the city which is 0.38 pCi Rn/liter.

It is impossible that the predicted value of an additional 1.0 pCi Rn/liter at 0.4 mile and 0.6 pCi Rn/liter at 0.5 mile from the pile could have escaped detection. The power function model of Equations (1) and (3), and of Table 4-2 is invalidated by the experimental evidence of radon dispersion as measured at 4 different inactive tailings piles. The dispersion model overestimates the radon concentrations. The incorrect assumption of 50% decay product equilibrium further enhances the overestimate of exposure values in WL units. For the important close-in distances in the vicinity of 0.5 mile or less the combined overestimate can easily exceed a factor of 10.

A more sophisticated model for the dispersion of radon from a large tailings pile has been reported elsewhere (F. F. Haywood et al. "Assessment of Radiological Impact of the Inactive Uranium-Mill Tailings Pile at Salt Lake City, Utah", ORNL/TM-5251 (1977)). This model uses the Oak Ridge "Comprehensive Atmospheric Transport and Diffusion Model" of Culkowski and Patterson (ORNL-NSF-EATC-17, 1976). Radon concentrations predicted by this elaborate model are compared with the values measured experimentally by Shearer and Sill for the Salt Lake City pile in Table 14 of the F. F. Haywood et al. document. At every one of the 10 away-from-pile measurement stations, ranging from 0.3 to 2 miles from the Salt Lake City pile, the ORNL model also overestimates the actual observed radon concentration. Again, the discrepancies are particularly large for locations nearest to the edge of the pile.

I was peripherally involved in the 1967 to 1968 radon studies by Shearer and Sill at Grand Junction, Salt Lake City, Durango, and Monticello, and I can personally certify to the accuracy of their sampling procedures and of their radon measurements. Where there is disagreement between a theoretical model and the measured radon concentrations it is the model which is inaccurate.

The conclusion is inescapable that the particular radon dispersion model used, and indeed any known model grossly overestimates the actual radon concentrations attributable to the tailings piles. Therefore, all of the estimates of attributable lung cancer for the "local" (0 to 6 miles), "regional" (6 to 50 miles), and "national" (beyond 50 miles) populations become invalid overestimates.

2. RADON FLUX: NATURAL and MAN-MADE

The average concentration of radium-226, in equilibrium with its parent uranium-238, in surface soils and rocks is in the domain of 1 pCi Ra/g of earth. At this concentration the content per square mile of ordinary land, to a depth of 1 foot, is 2 grams (or 2 Curies) of radium and 6 tons of uranium. A portion of the radon-222 produced by radium in the soil and rocks escapes from the crystal grains and diffuses slowly throughout the interstitial voids. Some of this diffusing radon, mostly from within less than 2 meters from the surface, reaches the earth-air interface and escapes into the atmosphere. The flux of radon which diffuses through the earth-air interface depends on several characteristics of the soil or rock, including porosity, moisture content, grass or other cover crops, freezing and thawing, and also on fluctuations in barometric pressure and surface wind speed. A reasonable annual average value is 1 pCi $Rn/m^2 \cdot sec$, with variations expected mostly in the domain of 0.5 to 5 pCi $Rn/m^2 \cdot sec$. Rundo et al. measured a flux of 7 pCi $Rn/m^2 \cdot sec$ from soil containing about 1 pCi Ra/g in the unpaved crawl space under an Illinois home (Health Phys. 36, 729-730 (1979)).

If the average inactive unstabilized uranium tailings pile releases a radon flux of 640 pCi $Rn/m^2 \cdot sec$ (J. J. Swift et al. EPA-520/1-76-001, page 12), then each square meter of tailings would have the same radon release as 640 square meters of ordinary land. In the same ratio, each acre of inactive tailings would have the same radon release as 640 acres of land. But 640 acres is one square mile. Thus we have the handy-dandy rule of thumb that on the average each acre of inactive tailings releases to the atmosphere the same quantity of radon as one square mile of land, prairie, back yard, pasture, or desert. In brief, for radon release:

$$\text{1 acre of unstabilized inactive tailings} \simeq \text{1 square mile of ordinary land} \quad (4)$$

The Salt Lake City uranium tailings pile is one of the largest which is near a well-populated region in the U. S. Its area is given as 100 acres (DEIS, page 3-3). The radon released from the inactive uranium pile at Salt Lake City is therefore equivalent to that from about 100 square miles of natural land, or a circle 5.6 miles in radius.

The Great Salt Lake lies in Salt Lake City's front yard to the northwest. In 1976 the water level in the Great Salt Lake had risen about 11 feet above its level a decade earlier. The lake had spread "over 1,700 square miles - nearly twice the surface of a decade ago." (Utah's Great Salt Lake Advisory Board: United Press International, Oct. 24, 1976). Thus some 800 square miles of land became covered by water, and had its radon flux cut off. This natural process therefore reduced the annual radon released into the Salt Lake City regional air by 8 times as much as the annual release from the tailings pile. On a regional basis, even this great tailings pile near a heavily populated area has an atmospheric radon influence which is not only overwhelmed by the natural radon flux of the area but is much smaller than the fluctuations in the regional radon flux which are caused by variations in the water level in the Great Salt Lake. If the radon emission from the lake shore is not worth controlling, what magnitude of resources should be expended to minimize the much smaller radon emission from the tailings pile?

Moving along to the national scene, the total area of all the 23 inactive uranium tailings piles, as listed on pages 3-2 and 3-3 of the DEIS, is 1021 acres. Most of these have tabulated radon flux rates which are substantially smaller than the nominal 640 pCi $Rn/m^2 \cdot sec$. But for ease of visualization, we may consider 1000 acres of inactive tailings with nominal radon flux. Then all the inactive tailings, if unstabilized, have a total radon emission equivalent to not more than 1000 square miles of land area. How shall we visualize 1000 square miles? It is smaller than the area of a square 32 miles on a side, or of a circle with a radius of 18 miles. One thousand square miles is less than 1% of the area of Colorado, or of Nevada. It is less than 1/3000th (1/30th %) of the area of the 48 continental United States. Moreover, these states contain over 55,000 square miles of inland water, hence every 2% change in the area of inland waters changes the national radon emission by an amount exceeding the total radon emission from all inactive uranium tailings piles. The Great Lakes have an area of some 95,000 square miles, hence every 1% change in their shoreline area changes the radon emission by as much as all the unstabilized inactive tailings piles.

The Netherlands have been gradually diking portions of the Zuyder Zee and have created a total of 3,000 square miles of new land for agricultural and other uses (Encycl. Brit. Macropedia, 12, p. 1058 (1974)). Thus the radon emission from the new land area created in The Netherlands exceeds by a factor of 3 the radon emission from all U. S. inactive uranium tailings piles. Would the Dutch, or any of their neighboring nations, initiate remedial action to suppress this man-made radon release? Would anyone contend that 3000 square miles of new land is an environmental hazard or that it introduced a risk of premature or excess deaths from lung cancer?

The radon flux from farm land is influenced by many factors. Plowing exposes new surfaces and radon-rich interstitial voids from beneath the surface. There is surely a net surge of radon release during and for some time after plowing. Crops and other plants and trees, whose roots are in the subsurface interstitial spaces, where the concentration of diffusing radon is high, bring radon through their own pores and can increase the overall radon emission per unit area of soil by as much as a factor of 2 or 3 for some broad-leaf crops (J. E. Pearson and G. E. Jones, Tellus 18, 655-662 (1966)). Large changes in radon flux are also produced by flooding or drought and by freezing or thawing.

Significant increases in the radium-226 content, and hence in the radon flux from agricultural lands in Illinois and other midwest areas, have been produced by the use of some phosphate fertilizers and ground waters with elevated radium content, as Norman Frigerio pointed out several years ago.

In summary, the total radon released from all inactive unstabilized uranium tailings piles is a minute fraction of the variations produced by meteorological conditions and agriculture in the total radon released by natural processes from all land areas. The level of radon-decay-product exposure at distances greater than 1/4 to 1/2 mile, is a minute fraction of the range of fluctuation of the natural background in the area. Under the ALARA principle no substantial action to reduce the exposure is warranted.

Addition of the radon flux from the tailings of <u>active</u> uranium mills does not change any of these generalizations. An earlier EPA statement of the total area of tailings piles in 1970 (presumably in the U.S.A.) was 2100 acres (EPA-520/9-73-003-B, (1973), page 51). If this estimate was accurate it would imply that the active tailings piles were substantially equal in area to the inactive piles. This would not double the total radon released because many of the active piles have a high moisture content. ORNL concluded that "moist tailings" emit only 50% as much radon as "dry tailings", while "wet tailings" emit only 20% as much radon as dry tailings (ORNL/TM-5251, page 18). Submerged tailings can release substantially no radon to the atmosphere. In view of Shearer and Sill's observation that the inactive piles at Salt Lake City, Grand Junction, Durango, and Monticello produce no measurable increase in the atmospheric radon concentration at distances greater than 1/4 to 1/2 mile, it is comforting, but not surprising, that Professor Marvin Wilkening could detect no radon from all the tailings piles plus mine ventilation exhausts from Ambrosia Lake at his laboratory in Socorro, NM, a downwind distance of nearly 100 miles (Personal communication, May 18,1981).

3. LUNG CANCER RISK FACTORS

Estimates of the health effects due to radon emission from inactive uranium tailings piles depend multiplicatively on three factors: radon flux, radon dispersion in the environment and the growth of radon decay products with elapsed time, and the lifetime lung cancer risk factor per working-level-month (WLM) of inhaled radon decay products. We have seen that the measured values of radon concentrations are very much smaller than the values derived from theoretical models. Therefore the health effects were overestimated.

In the following discussion we will see that the lifetime risk factors per WLM were also overestimated. These risk factors also contribute to the proposed overrestrictive standards for radon flux after stabilization and for working level (WL) values in occupiable buildings.

<u>Health Effects Estimates in FR81</u>.

Quantitative estimates of health effects are treated in paragraphs numbered 2 and 4 in column 1 on page 2558 of FR81. In paragraph 2 we read:

> "For example, we estimate that individuals living continuously one mile from a large pile would have about 200 times as great a chance of a fatal lung cancer caused by radon decay products as persons living 20 miles away (7 in 10,000 versus 3 in 1,000,000)."

This unfortunate sentence is obviously a misstatement. We recall that there is no measurable difference in the ambient atmospheric concentration of radon at distances greater than 1/4 to 1/2 mile from large unstabilized inactive piles. Any contribution from the pile is a small fraction of the normal fluctuations in the annual average background due to meteorological and horticultural variables. The author of the quoted sentence may have had in mind only pile-produced radon. But that is is not what the prose says. A lay reader, a legislator, or a state or county officer could be totally misled concerning the effective radius of pile-produced radon.

The truth is there is no significant difference between 1 and 20 miles, not a factor of 200.

The estimates in paragraph 4 concerning national effects on persons living more than 50 miles away from a pile, "40 to 90 deaths from lung cancer per century", (or 0.4 to 0.9 per year, out of an unstated national total of 92,000 per year) is also both misleading and invalid.

Even though the possible detriment or harm from pile-produced radon is much smaller than estimated in FR81 and the DEIS, I agree that the detriment from other airborne radionuclides (U, Ra, Po, etc.), or from gamma radiation are "far less significant" (FR81, p. 2558, line 3), indeed they are negligible. A year-long survey in 1974 at a station on the Salt Lake City pile showed that none of 26 separate samples of airborne dust had activities greater than the MPC_a for Ra-226, Pb-210, Po-210, Th-230, U-234, U-235, or U-238 (F. F. Haywood, et al. ORNL/TM-5251, page 21). Also the gamma radiation from this large unstabilized pile is small, decreases rapidly with distance from the pile (Haywood, loc. cit., page 61), and would be reduced everywhere to normal background levels by a covering of less than two feet of earth (DEIS, page 5-8).

Health Effect Estimates in the DEIS.

With respect to radon decay product risk factors FR81 properly states that (page 2558):

> "Additional uncertainty comes from our incomplete knowledge of the effects on people of these generally low exposures"

The DEIS estimates of lung cancer risk (pages 4-6 to 4-11) per WLM involve both relative risk and absolute risk. My preference is for absolute risk, which coincides with yours, with that of Jacobi, Stewart, McLean, and Harley, and with ICRP and NCRP. For absolute lifetime risk the DEIS appears to have as many as 4 different values in a span of 4 pages of text. These warrant discussion and comment, for resolution in future publications.

On DEIS page 4-8, we read:

> "For absolute risk, we use the estimate of 10 lung cancer deaths per WLM for one million person-years at risk reported by the National Academy of Sciences (NA76)."

The bibliographic reference (NA76) is not found in the list of References. From a similar statement credited to "Na76" in EPA 520/4-78-013 (1979) on Florida Phosphate Lands the reference must be a National Research Council report supported by the EPA Office of Radiation Programs on "Health Effects of Alpha-Emitting Particles in the Respiratory Tract", issued in October 1976 as EPA 520/4-76-013.

That entire document actually relates to the plutonium "hot particle" flap generated by a Cochran and Tamplin hypothesis which fueled the National Resources Defense Council petition to the EPA that the plutonium-in-lung standard be reduced by a factor of 115,000. The major issues relate to the relative insensitivity to radiation displayed by the alveolar region of the animal and human lung, as compared with the hilar region. The conclusion was that for inhaled insoluble plutonium aerosols "the carcinogenic response is more a function of the amount of radioactivity in the lung than its distribution". Thus "hot particles" of plutonium were judged to be no more hazardous than a uniform distribution.

The 18-page report has a 77-page appendix comprising comments on usually relevant topics by the committee members. One of the 10 members of this ad hoc committee on hot particles was Professor Edward Radford. Ted Radford's 3-page contribution to the appendix deals mainly with the location (alveolar vs. hilar) of lung tumors associated with various agents including cigarette smoke, asbestos, compounds of arsenic, nickel, and chromium, various organic chemicals, and alpha radiation. He commented on the 1972 BEIR report estimate of 0.63 cases per 10^6 person-rem-year for the radon decay product risk factor for underground uranium miners (not for members of the general population), then stated"

> "Finally, it has been possible to update the U. S. uranium miners study group to 1972 (88). ... modifying the definition of period of risk ... to 10 years after beginning of mining ... results in a revised absolute risk of about 2 cases/rem/10^6 person-years."

Radford's bibliographic reference (88) to support this conclusion is:

88. V. E. Archer and E. P. Radford, unpublished data, 1975.

Thus no supporting data have been supplied, and Radford's recommendation in 1976 has never had peer review. Radford did not express his risk factor in units of WLM. The dosimetric conversion used in the 1972 BEIR report was 5 rem = 1 WLM. Applying this to Radford's statement would make his risk factor for uranium miners 10 cases per WLM for 10^6 person-years as used for the general public in EPA 520/4-78-013 on Florida Phosphate Lands and in the DEIS. This 10^{-5} per WLM · yr is derived from a proposal of Radford's, rather than being the concensus of any committee of the National Academy of Sciences.

When this per-year risk estimate is integrated over a 70-year average lifespan, assuming that the per-year risk factor is independent of age and does not diminish with time after exposure, that the rate of exposure in WLM/year is constant, that competing causes of death do not shorten the average lifespan, that a 10-year minimum latency is associated with each element of acquired risk, and that therefore the accumulation of risk and associated "wasted" WLM terminates 10 yrs before the end of the 70-year lifespan, then the 10^{-5} risk factor per year and per accumulated WLM integrates to an equivalent lifetime risk of 3.0×10^{-4} per accumulated WLM.

This numerical correspondence between the risk per year and the lifetime risk is in agreement with a relationship which can be derived from an example of lifetime risk given in Table 10 of the Florida Phosphate Lands document EPA 520/4-78-013. Hence we appear to be in agreement that under the assumptions listed above, the integrated relationship is:

$$\begin{pmatrix}\text{lifetime}\\ \text{risk}\end{pmatrix} = \frac{1}{2}\begin{pmatrix}\text{risk per}\\ \text{yr} \cdot \text{WLM}\end{pmatrix}\begin{pmatrix}\text{life-long exposure}\\ \text{rate in WLM/yr}\end{pmatrix}\begin{pmatrix}\text{lifetime minus}\\ \text{latency, in years}\end{pmatrix}^2 \qquad (5)$$

A second estimate of the lifetime absolute risk factor can be deduced from the statement (page 4-9 of DEIS) that a life table analysis yields a 0.6% lifetime risk for continuous exposure to 0.01 WL. Assuming that the 10-year latency concept has been retained in this life-table analysis, the relevant lifetime exposure, using the 27 WLM/WL yr conversion factor from page 4-6, is

$$(0.01 \text{ WL})(60 \text{ yr})(27 \text{ WLM/WL yr}) = 16.2 \text{ WLM},$$

and the lifetime risk factor would be $0.006/16.2 = 3.7 \times 10^{-4}$ per WLM. It is interesting that the shortening of some lives by intercurrent disease or trauma, which occurs through the use of a life-table analysis, results in a higher lifetime risk factor rather than a lower one. Incidentally, the lifetime risk of lung cancer in the general U.S.A. population is said to be closer to 4% than to the 2.9% stated, on page 4-9, to have resulted from the Cook et al. computer program and life-table analysis. The discrepancies may be related.

A third estimate of lifetime risk is implicit in the statement at the bottom of page 4-9 of DEIS, which reads:

> "A person's average annual risk from a lifetime of exposure may be obtained by dividing the lifetime risk estimates given above by an average lifespan of 71 years."

This would mean that the lifetime risk is the annual risk multiplied by 71 years, or $(10^{-5}/\text{WLM} \cdot \text{yr})(71 \text{ yr}) = 7.1 \times 10^{-4}$ per WLM. The integrations which lead to Equation (5) may have been overlooked when this simple relationship was stated.

A fourth estimate of absolute lifetime risk is the statement on page 4-10 of DEIS:

> "... our firmest estimate is that increased levels of radon will produce an additional 1 to 3 lung cancer deaths per year of exposure for each 100 person-working-levels of lifetime exposure".

For 100 persons at one WL, and the conversion factors and latency already discussed, this is a lifetime exposure of $(1 \text{ WL})(27 \text{ WLM/WL yr})(70 - 10 \text{ yr}) = 1620$ WLM. Then the lifetime risk factor per person would be $(1 \text{ to } 3 \text{ deaths/yr})(60 \text{ yr})/(100 \text{ persons})(1620 \text{ WLM}) = 3.7 \text{ to } 11.1 \times 10^{-4}$ per WLM .

Thus the 4 pages of the DEIS which deal with the lung cancer risk factor seem to contain 4 different values for the lifetime absolute risk factor in units of 10^{-4} per WLM, namely 3.0, 3.7, 7.1, and 3.7 to 11.1. The range is nearly a factor of 4.

<u>Update of Lifetime Risk Factor</u>.

Fortunately this uncertainty can be resolved easily in a later version of the EIS. As you know, there has just become available the "international concensus" risk-factor which resulted from a week-long workshop of invited international specialists invited by the Nuclear Energy Agency of the Organisation for Economic Cooperation and Develpopment in Paris to convene at the EPA offices in Arlington in 1978. As you know from your participation, the task group on radon included the leading experts at the extremes of modeling (W. Jacobi) and of epidemiology (C. G. Stewart) and all views in between. The manuscript recommendations of Archer, Radford, Axelson, et al. were in hand. These were rejected, as was their paper when later independently refereed and rejected by the editor of Radiation Research.

The radon task group easily reached unanimous agreement that the upper limit of lifetime absolute risk is 1 x 10^{-4} per WLM for members of the general population. The radon task group's findings were accepted by the international workshop membership as a whole, which included strong representation of the ICRP (D. Beninson, B. Lindell, and others) and representatives of other nations besides the 4 nations represented in the radon task group. The text of the radon task group's recommendations apparently got lost somewhere in the communication chain between the OECD, IAEA, and ICRP, and did not appear anywhere in print. Following nearly 2 years of subsequent correspondence, and a long series of drafts which resulted in unanimous agreement on all final details of wording, the conclusions have at last been published in the open literature. The reference is of course, R. D. Evans, J. H. Harley, W. Jacobi, A. S. McLean, W. A. Mills and C. G. Stewart, "Estimate of Risk from Environmental Exposure to Radon-222 and Its Decay Products", Nature 290, 98-100 (March 12, 1981). The authors noted that 10^{-4} per WLM was to be taken as the upper bound, and that "the estimate of risk for low-level exposure may even include zero as a lower bound."

I, for one, feel that the EPA now has a clear scientifically-based mandate to adopt 1 x 10^{-4} per WLM as its upper limit for the lifetime absolute risk factor in all future considerations of possible radon decay product health effects.

Influence of Risk Factor on Proposed Standards.

Adoption of 1 x 10^{-4} per WLM in place of values between 3.0 and 11.1 x 10^{-4} per WLM will reduce all estimated health effects by a factor somewhere between 3 and 10. Standards which were proposed on the older basis of risk can be relaxed to 3 to 10 times the proposals in FR81. This shift is in addition to, and in the same direction as, the corrections discussed earlier for radon-decay-product dispersion patterns.

Updating the DEIS Text.

Incidentally, in a rewrite of the DEIS section 4.3 on lung cancer risks, it would be appropriate to replace the references EP78 and AR79 in the opening paragraph by a more representative selection of recent reports. Archer's AR79 is an almost inaccessible paper at a symposium, and had no peer review. His most recent full compilation and tabulation of the USPHS study cases, in a refereed journal, is, I believe, V. E. Archer, J. K. Wagoner, and F. E. Lundin, Health Phys. 25, 351-371 (1973), and this would be a good basic reference. (These are most probably the data with which Ted Radford made his recalculation of per-year risk in 1976). Figure 4-2 on page 4-7, from Archer 79, is related to the rejected Archer-Radford-Axelson manuscript and should be deleted because it is so misleading. The Czech, Canadian, and Swedish data involve confounding variables and should not be plotted with U.S. data. Two references which would enhance the bibliography in the opening paragraph are, of course, D. K. Myers and C. G. Stewart, "Some Health Aspects of Canadian Uranium Mining', AECL-5970, Chalk River Nuclear Laboratories (1979), and W. Jacobi and K. Eisfeld, "Dose to Tissues and Effective Dose Equivalent by Inhalation of Radon-222, Radon-220 and Their Short-Lived Daughters", GSF-Report S-626, Institut fur Strahlenschutz, Munich (1980).

In Summary.

The DEIS gives 4 different values for the lifetime absolute lung cancer risk factor, ranging from 3.0 to 11.1 in units of 10^{-4} per WLM, i.e., per 10,000 person-WLM. These risk factors derive from unpublished data, never given peer review, and relate only to underground uranium miners. For the low-level exposure of the general population, not involved in underground labor, the recently published recommendation by six widely recognized senior specialists from four countries should be used. This is a lifetime risk with an upper bound or maximum value of 1×10^{-4} per WLM, and with a lower bound which may include zero.

4. WORKING LEVEL AND WORKING LEVEL MONTHS PER YEAR

The DEIS uses 27 WLM for the full time continuous exposure of members of the general population to one WL for a year, that is 1 WL yr = 27 WLM. The month (M) in WLM is defined correctly as 170 hours on page 4-6 of the DEIS. The correct relationship for full time 100% occupancy is:

$$1 \text{ WL yr} = 1 \text{ WL yr}(8760 \text{ hr/yr})/(170 \text{ hr/M}) = 51.5 \text{ WLM} \qquad (6)$$

The 27 WLM conversion factor was based on the fact that members of the general population breathe fewer liters of air per month than do underground uranium miners (DEIS, page 4-6, and page 48 of the Florida Phosphate Lands EPA 520/4-78-013).

But under the universally accepted definitions of WL (1.3×10^5 MeV of short-lived potential alpha energy per liter of air) and of the working month, M, (170 hours, rounded from 173), the WLM unit is totally independent of breathing rate. For example, members of the general public or miners working at an altitude of 6000 to 7000 feet will have a breathing rate about 20% greater than persons in similar activities near sea level because of the lower density and hence lower oxygen content per liter of air, at higher altitudes. Breathing rate is in no way involved in WLM determinations, which are based only on the radioactivity content per liter of air multiplied by duration of exposure.

The significant difference in breathing rate between uranium miners and members of the general public at the same altitude is only one of many parameters which require two lung cancer risk factors, - one for uranium miners and a smaller one for members of the general public, as discussed earlier. Breathing rate is already accounted for in the maximum lifetime risk factor of 10^{-4} per WLM.

5. FRACTIONAL OCCUPANCY TIME

The conversion factor 1 WL yr = 27 WLM can be salvaged and justified on a basis of fractional occupancy time. What you would need would be an average occupancy factor of 27/51 = 0.53. If a work place is being considered, then the occupancy factor would be about (170 working hours per month)/(730 clock hours per month) = 0.23. Only part of the remaining fraction 0.77 of the time is spent in the place of residence. (The 0.75 occupancy factor for a residence as adopted in the Florida Phosphate document, page 48, seems too high in spite of its distinguished parentage).

With respect to residences, most people do not spend a 70-year lifetime in one residence, but rather in perhaps 5 to 10 houses. If one or two of these houses had a substantially elevated radon decay product level, an individual's lifetime average exposure could still be in a comfortable range. With this factor in mind, regulatory guides on permissible WL levels in homes or work places should recognize that the lifetime average WL exposure rate is more important than the maximum WL experienced in a particular home or work place.

Probably an average occupancy factor in the vicinity of 0.5 or less would be easy for you to justify, and hence to retain the 1 WL yr = 27 WLM, or even to adopt some smaller value.

6. INDOOR RADON DECAY PRODUCT CONCENTRATION STANDARD

Remedial actions at sites designated under PL 95-604 are "... clearly directed at potential health problems due to tailings ..."(DEIS, page 8-28). Also "... the proposed remedial action level of 0.015 WL (including background) for occupied or occupiable buildings is the most protective level that can be justified for the PL 95-604 remedial action program" (DEIS, page 8-27).

The justification seems to be based on the engineering practicability of achieving levels as low as 0.015 WL, rather than on estimation of the health risk in comparison with other risks regularly accepted in everyday life. It is also quite properly noted that surveys of normal houses with basements in New York, New Jersey, and Grand Junction, without tailings, indicate that (DEIS, page 8-27):

> "... about 10% or more are above 0.015 WL. We have concluded that efforts to reduce levels significantly below 0.015 WL by removing tailings would often be unfruitful, and the funds expended wasted."

If an action level as low as 0.015 WL for tailings remedial action were to be extrapolated by some agency at a later time to normal homes without tailings then several million existing normal homes in the U. S. ("about 10% or more") would become subject to remedial action, recognizing that natural radon from the soil is radiobiologically the same as radon from uranium tailings or from phosphate lands.

An action level as low as 0.015 WL has an extremely high ratio of cost to benefit. This is being demonstrated in Grand Junction where already some $11,000,000 of federal and state tax money has been spent on tailings removal, and an equal additional amount is projected.

Recall that even the long-term widespread dispersion of uranium tailings in Grand Junction is not associated with any measurable excess in lung cancer, in leukemia, or in all cancers (T. J. Mason, et al., "Uranium Mill Tailings and Cancer Mortality in Colorado", J. Nat. Cancer Inst. 49, 661-664 (1972); M. Cunningham, Colorado Disease Bulletin, 6, No. 31 (1978); and NUREG-0706, Vol. II, p. A-34).

Remedial action is taken in Grand Junction for schools and homes at 0.01 WL above background, hence at something approximating 0.017 WL <u>including</u> background (if anybody could make measurements with such accuracy). Recalling 0.03 WL above background as the midpoint of the Grand Junction 0.01 to 0.05 WL gray area in which "remedial action may be suggested", it is interesting to note that the EPA categories of WL as tabulated for 133 measured structures in Polk County, Florida, has its most significant WL-category boundary at 0.03 WL including background, that is a category from 0.01 to 0.03 WL and another at 0.03 to 0.05 WL. No break point at 0.02 WL is discussed (Florida Phosphate Lands, page 23-25). However in the related subsequent publication in FR 44, 38664-38670, July 2, 1979, the recommended remedial action level for residences is an annual average of 0.02 WL, rather than 0.03 WL.

My letter to you dated October 16, 1979 discussed the problems of measurement and enforcement at the suggested 0.02 WL, and recommended that some higher value be chosen because, among other things, the lung cancer risk factor had been overestimated. Now the DEIS document and FR81 have suggested a still lower action level, 0.015 WL. Thus over a span of about 3 years the EPA's suggested action level appears to have been sequentially tightened from 0.03, to 0.02, to 0.015 WL, whereas in the meantime the newer scientific evidence has indicated considerably less risk per WLM than previously assumed.

From the standpoint of the accuracy of environmental measurements or knowledge of radiobiological effects, a standard expressed to 2 significant digits, such as 0.015 WL is unrealistic. Even a single significant digit, such as 0.02, 0.03, or 0.04 WL may imply unwarranted accuracy.

The lung cancer lifetime risk factor of 1×10^{-4} per WLM, as an upper bound, implies that an exposure rate of 1 WLM per year carries less risk of all cancers than does the whole body exposure to 0.5 rem per year, which is the NCRP, ICRP, and 10CFR20 permissible level for members of the general public. Using your 1 WL yr = 27 WLM conversion, 0.04 WL corresponds to 1.1 WLM per year, and 0.03 WL corresponds to 0.8 WLM per year. I therefore recommend either 0.03 WL or 0.04 WL, in place of 0.015 WL, as the minimum annual average for indoor air which requires remedial action if it is caused by "residual radioactive materials from any designated processing site".

With the lifetime risk factor of 1×10^{-4} per WLM in view, as compared with 3 to 11×10^{-4} per WLM used in the DEIS, the lifetime risk of 0.04 WL is less than the lifetime risk which had been associated with the proposed 0.015 WL.

It should be noted that it would be incorrect to use 1/10th of the occupational level of 4 WLM/yr, that is 0.4 WLM/yr for the general population. This is because of differences in breathing rate, environmental factors, age and sex distributions, etc., which led to the designation of 1×10^{-4} per WLM as the upper bound of lifetime risk for the general population.

In summary, with newer risk factors and cost effectiveness in view, an action level of 0.03 WL or 0.04 WL would involve less risk and much less implementation cost than had been associated with the 0.015 WL proposed in FR81, 40CFR paragraph 192.12(b) and Table B.

7. RADON FLUX FROM STABILIZED TAILINGS PILES

The total radon released from all inactive uranium tailings piles is a minute fraction of the variations in the total radon released from ordinary soil, rock, desert, and prairie, as discussed earlier. The level of radon-decay-product exposure from unstabilized uranium tailings piles at distances greater than 1/4 to 1/2 mile is a minute fraction of the range of fluctuation of the natural background in the area.

Only long-term exposures very near to the pile, or directly on the pile, actually have any possible interest as potential health hazards. Quantitatively the DEIS estimate for the local (0 to 6 miles) population near the piles at Salt Lake City, Grand Junction, and 4 other southwestern piles is less than 1 lung cancer per year (DEIS, pp. 4-14 to 4-16). This is an overestimate, by more than a factor of 3, because of the dispersion model and risk factors used. Even so, it is insignificant compared with the unrelated expectation of about 100 lung cancer deaths per year among the 416,000 persons living within 6 miles of these 6 inactive tailings piles.

Thus there really is no significant health problem due to radon flux from the unstabilized tailings piles. The piles could be stabilized and provided with a physically sturdy and durable cover of soil and vegetation. The cover should be designed to prevent erosion and dispersion of tailings by weather (rain, snow, ice, and wind). A weather-resistant cover would be sufficiently thick to reduce the radon flux by probably a factor of at least 10, that is from a nominal 640 pCi $Rn/m^2 \cdot sec$ to the domain of 60 pCi $Rn/m^2 \cdot sec$. I know of no radiobiological reason for any further reduction, provided that habitable structures are excluded from the immediate area of the pile.

I know of no scientific basis for the proposed 2 pCi $Rn/m^2 \cdot sec$. Such a standard would involve substantially more expense and more possibility of serious harm to workers and the general public due to the hazards of moving large amounts of earth. With the provisions in PL 95-604 for Federal custody of disposal sites after completion of the remedial action program, it would seem that a small buffer zone, landscaped but without houses, around a stabilized pile would more than suffice for radiological safety. Thus the purposes of PL 95-604 as stated in Section 2(a) would be fulfilled. Far from being an eyesore, a properly stabilized and landscaped pile could be an attractive public park. Whatever radon flux exists on the stabilized pile has zero WL of decay products initially, and decay products are likely to become measurable only off the pile several minutes downwind.

The problem of estimating the attenuation of radon flux from tailings material by layers of overlying semiporous materials has been the subject of many mathematical studies. Extrapolating from the pathfinding work of Kraner, Schroeder, and Evans at M.I.T. in the early 1960's I believe that many of the recent mathematical models and computer printouts are inaccurate. You will recall my concern that much of the material in the NRC's April 1979 Draft Generic Environmental Impact Statement on Uranium Milling, NUREG-0511, was dubious. In particular, the mathematical formulation for multilayered systems involving widely different diffusion coefficients and porosities, as given in Appenx P of NUREG-0511, seemed impossible to accept. That simple exponential formulation however seems to have been adopted in the DEIS in Chapter 4 and Appendix B. A very much fancier theory appeared in the revision of Appendix P found in the Final GEIS on Uranium Milling, NUREG-0706, dated September 1980.

However I can at this time give full support to the situation in which the tailings material and the cover material have the same diffusion coefficient and porosity. Then all formulations agree that the radon flux due to the pile will be attenuated with exponential dependence on the thickness of the overburden. This special situation allows the concept of half-value-layer (HVL) to be used, so that for thickness t of overburden the transmitted flux is proportional to exp(-0.693t/HVL), as is implicit in the table and graph on pages 5-4 and 5-5 of the DEIS.

The much more complicated dependence when several layers of dissimilar overburden are used may eventually be clarified by full scale experiments which are in a very early stage at the inactive Phillips and United Nuclear pile at Ambrosia Lake.

The text of FR81 is flawed with respect to the proposed radon emission standard of 2 pCi $Rn/m^2 \cdot sec$. We note that all the backup material in the GEIS operates on a pure single exponential model, exp(-0.693t/HVL). The HVL is taken as a characteristic of the particular overburden material.

Then see FR81, page 2559, column 2,

> "Several analyses[6] of controlling radon emission by covering piles with soil suggest that the required covering thickness rises sharply[7] near an emission rate of about 1 $pCi/m^2 \cdot sec$."

This statement is as obscure and meaningless as saying that for an isolated radioactive source with an initial activity of say 600 mCi the time one has to wait for the activity to decrease rises sharply near an activity of about 1 mCi.

The footnote "7" is even more confusing. It reads:

> "Reducing the emission rate from 10 to 9 $pCi/m^2 \cdot sec$ (a 10% reduction) requires about 1 cm of added soil: the same size reduction from 2 to 1 $pCi/m^2 \cdot sec$ (50%) takes about 50 cm of added soil."

The author of these selections seems to be unclear on the behavior of exponential systems as compared with linear systems. In this case, if a 50% reduction takes 50 cm of added soil, then the half-value-layer (HVL) is 50 cm. The addition or subtraction of 50 cm of soil will always change the transmitted flux by exactly a factor of 2. This is simply because exp(-0.693t/50) = 1/2 when t = 50. But for a reduction from 10 to 9 $pCi/m^2 \cdot sec$, we have 9/10 = exp(-0.693t/50), from which it follows that t = 7.6 cm (not "about 1 cm") for <u>any</u> 10% reduction in flux. The numerical illustration in footnote 7 is not a misprint, it is simply wrong.

Still in column 2, of page 2559, of FR81, we read:

> "Higher control levels, say 10 - 40 $pCi/m^2 \cdot sec$ appear unjustified because emission rates of that size can be lowered to 2 $pCi/m^2 \cdot sec$ for about 10% additional cost."

This seems to be another example of some writer's difficulty with exponential functions and multiplicative relationships. To reduce from even a large initial flux of say 600 $pCi/m^2 \cdot sec$ to 40, is a reduction factor of 600/40 = 15. This requires (ln 15)/0.693 = 3.91 half-value-layers. To drop from 40 to 2 $pCi/m^2 \cdot sec$ is a reduction factor of 40/2 = 20. This requires (ln 20)/0.693 = 4.32 additional half-value-layers. Far from requiring "about 10% additional cost", going from 40 to 2 $pCi/m^2 \cdot sec$ requires 4.32/3.91 = 1.10 or 110% more material than was required to go from 600 to 40 $pCi/m^2 \cdot sec$. These relationships would be true for any covering material, as long as the exponential decrement is valid.

The entire section in FR81 on Proposed Radon Emission Standards is thus flawed by errors in mathematics and hence in reasoning.

I am not particularly troubled by these marked uncertainties and inaccuracies concerning radon flux reduction by overburden, because we have seen that the reasons advanced for proposing a 2 $pCi\ Rn/m^2 \cdot sec$ guideline are invalid. It is not needed radiobiologically, and it would be very expensive, cost ineffective and inflationary to spend tens of millions of dollars reducing the flux toward such unnecessarily low levels.

In summary, no radiobiological justification is known for the proposed radon flux limitation of 2 $pCi\ Rn/m^2 \cdot sec$. It is unnecessary for the "protection of the public health, safety, and welfare, and the regulation of interstate commerce." Its implementation through massive translocations of earth and/or tailings would be very expensive, would be inflationary to the economy, and would be hazardous to the health of workers and the general public. The mathematical justifications given in FR81 are distinctly inaccurate and hence the conclusions drawn from them are invalid. The underlying purposes of PL 95-604 with respect to radon flux suppression would be fulfilled by procedures equivalent to providing a sturdy and durable cover of soil and vegetation adequate to prevent erosion and dispersion of tailings by extremes of weather, such as rain, snow, ice and wind, and by including a small buffer zone without habitable buildings in the area under Federal or State custody after completion of the remedial action program.

8. GAMMA RADIATION FROM TAILINGS PILES

It is true that the gamma radiation from a uranium tailings pile is small and only offers a minute health hazard compared with the already very small health aspects of radon and its decay products. This is because the mean-free-path for the gamma rays of the radium series is only about 10 cm, or 4 inches, of tailings or dirt. Substantially all of the gamma radiation is self-absorbed within the pile. The external gamma radiation originates almost entirely from the outer one foot of tailings.

The attenuation of tailings gamma radiation by soil overburden is not given correctly by Figure 5-2, on page 5-8 of the DEIS. You would want to correct this in any later version of the EIS.

Figure 5-2 is simply a graph of an exponential attenuation, exp(-0.693 y/0.1), where y is the thickness of overburden in meters. However, pure exponential attenuation of gamma rays occurs only for a collimated beam or a point source.

In the case of an extended source, such as a flat surface on a tailings pile, much of the radiation emerging through any square centimeter of surface will have had a diagonal path within the extended source, and will therefore have suffered more attenuation than radiation emitted perpendicular to the surface. When the appropriate mathematics is carried out (see R. D. Evans and R. W. Raitt, Phys. Rev. 48, 171-176 (1935)) the attenuation of the gamma radiation from a uniform semi-infinite source by an overburden of thickness y and linear attenuation coefficient μ is given by the integral

$$E_2(\mu y) = \int_1^{\infty} e^{-\mu y z} z^{-2} dz \qquad (7)$$

This cannot be integrated in closed form but must be tabulated. Originally called the Gold integral (E. Gold, Proc. Roy. Soc. Lon. A82, 43 (1909)), $E_2(\mu y)$ is now known as one of a family of "exponential integrals". These are involved in the shielding of nuclear reactors. Convenient tables will be found in H.Etherington, "Nuclear Engineering Handbook", McGraw-Hill (1958), page 1-122.

The concept of half-value-layers does not apply to extended sources. The consequences are significant. For example the ratio of ext nded source attenuation, $E_2(\mu y)$, to point source attenuation, $\exp(-\mu y)$ for several values of μy is:

μy	0.693	1	2	4	6
$E_2(\mu y)/\exp(-\mu y)$	0.48	0.40	0.28	0.17	0.13

Thus Figure 5-2 of the DEIS underestimates the attenuation at 0.5 meters (20 inches) of soil by more than a factor of 5. The effectiveness of overburden in attenuating gamma radiation from a tailings pile is significantly greater than given in the DEIS. This bit of radiation physics can be corrected easily in any later version of the EIS. The 'R81 is not affected.

9. LONGEVITY OF DISPOSAL STANDARDS

The FR81 requests "... comments on whether 1000 years is the best choice." In my view "disposal", without any form of surveillance, is impracticable. When the National Academy of Sciences' "Committee on Radioactive Waste Disposal" began in 1968 one of the very first actions we took was to change the name of our committee by substituting "Management" for "Disposal". We felt that, in the very long term, occasional surveillance would be essential, and that a walk-away-and-leave-it-alone policy as implied by "disposal" was impractical. I still feel that way. "Management" procedures and standards are practicable, "disposal" is impracticable.

Is there any person or group of persons who can predict the course of mankind on this continent for the next 200 years, let alone a millennium? Could George Washington have predicted the present state of commerce, population, communication, or the healing arts? The Pueblo of Los Angeles, California, was founded just 200 years ago, in 1781 "... with a population of twenty-six including Mexicans, negroes, and half-breeds ... upon the site of the old Indian village, Yang-na..."(E. B. Carter, "Hollywood, the Story of the Cahuengas", H.H.S. Press, 1926). Its LaBrea tar pits were a death trap, but have been "managed" successfully.

The very advanced Aztec civilization in Central America could not have foreseen its destruction by Cortes in 1519. And even the Norman Conquest of England ("1066 and all that") and the Magna Carta (1215) were less than 1000 years ago. At present the mortality from all forms of cancer is only about one-half of the morbidity. Who can say what the cure rate will be in 20 years, or 200 years?

For what it's worth, with Federal or State custody of the tailings sites planned under Section 202 of PL 95-604 after remedial action is completed, 100 to 200 years seems to me to be a more than adequate time span.

10. RADIUM IN SOIL

The proposed 5 pCi Ra/g soil standard seems reasonable if it is intended to apply to cover materials near the surface. But what is meant by the provision "... in any 15 cm thickness below 1 foot, shall not exceed 5 pCi/g" (para. 192.12(a))? To what maximum depth "below 1 foot" does this proposal apply, 5 ft, 20 ft, 1000 ft? If it's to any considerable depth then the radon flux might be 5 pCi $Rn/m^2 \cdot sec$, - another reason for dropping the 2 pCi $Rn/m^2 \cdot sec$ concept.

11. RADIUM IN DRINKING WATER

FR81, in paragraph 192.03(b)(1) and Table A, repeats the EPA drinking water standard for combined radium-226 and radium-228 of 5.0 pCi/liter. As you know from prior correspondence and conversations I feel that this is unduly restrictive, inefficient in its cost/benefit ratio, and inflationary in the expenditure of manpower and money which it is causing. Other scientists who have had significant direct experience in the study of the radiobiological effects of radium share this view. If this is a time for reconsideration, please consider the following.

The effects of Ra-226 and Ra-228 in humans has been under quantitative experimental study for more than 40 years, and is probably the best understood of all radiobiological responses to low, intermediate, and high level radiation. The permissible body burden for Ra-226 was set at 0.1 μCi in 1941 based on all the cases which we had studied quantitatively up to that time (N.B.S. Handbook 27, NCRP Report No. 5). Now, 40 years and 2000 studied patients later, the 0.1 μCi Ra benchmark continues to be the solid basis for all radiation protection guides for radium in man by the

NCRP and the ICRP (e.g., NCRP Reports No. 11 (1953), No. 22 (1959), No. 39 (1971); ICRP Publication 2 (1959); Publication 30, Part I(1979)). This 0.1 µCi Ra standard does not depend upon any model of dose vs. response, or of estimated tissue doses in rad or rem. The Sr-90 and Pu-239 permissible levels were based upon this radium standard (ICRP Pub. 2).

The 0.1 µCi Ra bench mark was based on the directly measured residual body burden of patients, long after they had acquired a much larger initial burden, commonly the order of at least 100 times larger. When used as a radiation protection guide the 0.1 µCi bench mark represents not a residual burden but the maximum body burden reached during intake. Thus there is a substantial additional safety factor of between 1 and 2 orders of magnitude built into the conventional use of the 0.1 µCi Ra standard as the maximum body burden rather than as a residual body burden evaluated many years after exposure (see, for example, Figure 16 in R. D. Evans, "The Effect of Skeletally Deposited Alpha-Ray Emitters in Man". Brit. J. Radiol. 39, 881-895 (1966)).

The ICRP has given long and careful consideration to risk analysis, and to the risk associated with the ingestion of radium. Since the very first standards were proposed by ICRP and NCRP for internal emitters, radium standards have been based on the 0.1 µCi Ra benchmark while standards for other radionuclides have been based on calculations of rad, rem, Gray, and Sievert tissue doses.

The present ICRP occupational annual limit of oral intake (ALI) of radium is 70,000 Becquerels for Ra-226 and 90,000 Becquerels for Ra-228 (ICRP Pub. 30, Part 1, "Limits for Intakes of Radionuclides by Workers", page 99). For mixtures of Ra-226 and Ra-228 we may use the average, 80,000 Bq/yr, which is 220 Bq/day, or 6000 pCi/day.

The ALI and average daily intake were derived by using the alkaline earth retention model of John Marshall (ICRP Pub. 20) and determining what ALI for each of 50 successive years would result in a final body burden not to exceed 0.1 µCi Ra-226 (J. Vennart, Health Phys. 40, 477-484 (1981)).

This ALI of 7 to 9 x 10^4 Bq, or 2 x 10^6 pCi, already contains the considerable safety factor of 10 to 100 attributable to the use of maximum burden rather than residual burden, discussed above. If now an additional safety factor of 100 is applied for the general public as compared with radiation workers, the 6000 pCi Ra/day becomes 60 pCi Ra/day. The standard daily intake of drinking water is less than 1 liter/day (ICRP Pub. 23, page 360). But putting in still another safety factor by assuming 2 liters/day, leads to a value of 30 pCi Ra/liter as a very conservatively safe maximum permissible concentration for Ra-226 plus Ra-228 in drinking water.

Thirty pCi Ra/liter, expressed in S. I. units is 1 Bq/liter, which is the value adopted in Canada in 1978, prior to the publication of ALI values in ICRP Pub. 30. By coincidence, 30 pCi Ra/liter is the concentration which I recommended mostly on grounds of dosimetry and dose-response relationships in my 11-page commentary dated October 4, 1975 on EPA's 40CFR141, as well as in my letter of September 8, 1980 to William Lappenbusch of EPA's Office of Drinking Water. Those two commentaries led to the same recommendation as now results from ICRP's approach, which is happily independent of dosimetry or dose-response relationships.

In summary: based on long-term epidemiological studies and recent ICRP recommendations on annual limits of intake, raising the EPA drinking water standard for Ra-226 and Ra-228 from 5 pCi/liter to at least 30 pCi/liter can be shown to have a safety factor of at least 3 to 4 orders of magnitude with respect to the international radium MPBB standard of 0.1 μCi Ra. This can be shown without making any assumptions about the shape of the dose vs. response curve.

All of these comments are intended to be constructive. I hope they will be helpful. I will be glad to discuss any of these matters with you and your colleagues at any convenient time.

With best regards.

Cordially,

Bob

RDE:mms

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Testimony of Robert G. Beverly
Director, Environmental Controls Division
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Union Carbide Corporation

On Behalf of the American Mining Congress
On the Environmental Protection Agency's
Proposed Disposal and Clean-up Standards for
Inactive Uranium Processing Sites
(46 Fed.Reg. 2556, January 9, 1981)

May 14, 1981

The American Mining Congress is an association of companies engaged in every aspect of the mining and minerals processing industry. As such, the AMC represents the principal domestic producers of uranium. Because of the potential connection between the proposed standards for inactive uranium processing sites and future standards for active sites, the AMC, as a representative of its members, is an "interested person" entitled to comment on the proposed standards. For this reason, we express our appreciation for this opportunity to testify.

As a preliminary matter, we call the attention of the Agency to Executive Order 12291 (46 Fed.Reg. 13193, Feb. 19, 1981). This order, which was effective upon its issuance, requires in specific terms EPA to engage in cost/benefit analysis before promulgating any regulation. When proposing a major rule, the Executive Order requires the Agency to prepare a draft, and later a final, regulatory impact analysis to accompany the proposal through the regulatory process. We believe, for reasons hereafter stated, that the proposed inactive site standards constitute a major rule requiring a regulatory impact analysis. We, therefore, request that the comment period not be closed until the regulatory impact analysis is issued and until sufficient time is allowed for public comment upon it.

I. The Proposed Standards Fail to Conform to the Requirements of the Uranium Mill Tailings Radiation Control Act.

A. The Purpose of the Uranium Mill Tailings Radiation Control Act.

The Uranium Mill Tailings Radiation Control Act states that "uranium mill tailings...may pose a potential and significant radiation health hazard to the public" (emphasis added). From this statement, two points must be made. First, Congress did not find that uranium mill tailings present a significant hazard. Secondly, Congress indicates that it is significant health hazards that are of concern. Thus, the level of public protection contemplated by Congress is to be that which is necessary to minimize significant health hazards.

This intention is confirmed by the direction to develop a program "to stabilize and control...tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public" (emphasis added).

B. EPA Has Failed to Establish a Need for the Proposed Standards

The Act requires the development of a program to control tailings in a safe manner. A safe manner is not tantamount to a risk-free manner. The Act, as reasonably construed, requires only the minimization of significant risks of material harm.

EPA has not provided an adequate assessment of the nature and extent of the hazard, if any, posed by residual radioactive materials. EPA's analysis is based on a series of assumptions which conclude that some health effects may occur.

EPA acts on the assumption that any risk is unacceptable. However, as indicated by the decision in the Benzene case, Congress could not have reasonably intended EPA to have such authority. Before EPA can impose specific standards, it must be established that a significant risk of health hazard exists. This the Agency has failed to do.

No comparison with other, publically accepted risks is made. It is even admitted that at the low radiation levels involved, the effects may not be detectable (DEIS page 4-1). No clinical evidence of medically significant effects is presented. No attempt to realistically assess the harms and risks is made. Only a brief, pseudo-theoretical assessment of the health risks posed by the tailings piles is discussed. Further, this assessment makes no attempt to scientifically distinguish the various theoretical risk estimate techniques. The estimates are based on unpublished scientific documents which have not been subjected to peer review. For example, the health effects discussion in the Draft Environmental Impact Statement (DEIS) relies heavily upon a Florida phosphate study which relies on an unpublished report entitled "Facts in Exposure Response Relationships of Radon Daughter Injury" by V. E. Archer. This unpublished highly questionable report also is relied upon directly in the DEIS. Such use of unpublished information is inappropriate, especially when published, peer-reviewed information of high scientific credibility is available e.g. BEIR III, and "Estimate of Risk From Environmental Exposure to Radon-222 and Its Decay Products," R. D. Evans, et al., Nature, 290, March 1981.

To put the EPA estimate in perspective, the AMC offers the following information. The EPA assumed estimate is about 2 premature deaths per year. Setting aside the problem that such a low rate would not be detectable in the population, this assumed rate should be compared to other risks of fatalities. Other risks of fatalities per year, based on clinical evidence are: all accidents - 100,000; automobile accidents - 50,000; alcohol - 56,000; drowning - 8,000; poisons - 4,000; choking on food - 3,000; and firearms - 2,500. Thus, the 2 assumed fatalities per year from the inactive tailings sites represent several orders of magnitude less of a danger than many other actual risks commonly accepted by the public. NRC's Generic Environmental Impact Statement (NUREG-0706) estimates the maximum number of premature deaths in the U.S. from background radiation is 8,060 per year, this, compared to 2 premature deaths from uncovered tailings.

Thus, the entire costly remedial action standards are based not on substantive evidence of significant risk of material harm to be controlled, but on a series of assumptions and policy considerations designed to justify elimination of all possible theoretical risks which might be posed by tailings. Such standards are contrary to the Uranium Mill Tailings Radiation Control Act and are unreasonable and arbitrary.

II. DEIS Does Not Comply With the National Environmental Policy Act

The Uranium Mill Tailings Radiation Control Act requires that the program for control of tailings be conducted in an environmentally sound manner. The National Environmental Policy Act requires the consideration of the environmental impacts of the regulations. These two acts require that an assessment of the environmental impacts of the standards be conducted to assure that the least environmentally disruptive alternative is selected and that environmental mitigation measures are inlcuded where practicable.

The environmental impact assessment provided by EPA in the DEIS is inadequate. Only the hypothetical impacts of the tailings are considered in any depth. No evaluation of the detrimental environmental impacts of implementation of the proposed standards is made.

In the arid West, where many of the sites are located, stripping of land has very important reclamation considerations. Delicate vegetation is destroyed by both the actual earthwork itself and the movement of heavy equipment in the peripheral areas. Such vegetation must be replaced. The environmental and health effects of such actions have not been evaluated.

Earthwork and trucking activities involve substantial risks. For example, it has been estimated that a seven-year remedial action program to remove tailings from Salt Lake City will incur 5 fatalities and 62 injuries among the clean-up workers (Memorandum for the Record dated March 12, 1981, U.S. House Committee on Armed Services). Yet, EPA makes no attempt to evaluate these actual risks to remedial action workers against the hypothetical risks to the public from the tailings piles. EPA dismisses these known risks from occupational hazards as temporary and negligible (DEIS page 6-10). For the workers killed or injured, these hazards are not temporary or negligible.

Other risks associated with remedial action work to the levels in the proposed standards have not been given adequate evaluation. No evaluation of the potential public exposure as related to the exposure from other alternative standards has been made.

Moreover, the socioeconomic impacts of the standards have not been given adequate consideration. The simplistic assessment in the DEIS of temporary benefits does not justify the avoidance of consideration of impacts to the local human community. Consideration of potential impacts to the cultural/archaeological resources of the area were also ignored, contrary to the requirements of the National Historic Preservation Act.

III. The Proposed Standards are Unreasonable

A. <u>Natural Background Assumptions are Erroneous</u>

The proposed standards are based on the erroneous assumption that there is an "average" or "normal" background radiation level. Due to the extremely wide range of environmental conditions which exist in nature, the use of a computed average as the basis for the standards is unduly restrictive. The standards should either be on a site-specific basis or, if general standards are to be applied, they should be within the <u>range</u> of natural background. This would assure that present and future generations would not be subjected to risks that are different in kind or magnitude from those imposed by nature.

B. One Thousand Year Effectiveness

The selection of a 1000-year period is unreasonable. The state-of-the-art cannot be guaranteed to be effective for at least 1000 years. A time period of 100 years, during which there would be a reasonable expectation that the standards will be satisfied, would be realistic and reasonable. The time period selected should be based on what can reasonably be projected to provide control. On this basis, a target period of 100 years is reasonable.

C. Radium in Soils

The proposed clean-up standard for radium-226 in soils provides for reasonable assurance that in any 15 cm thickness below 1 foot, the Ra-226 concentration shall not exceed 5 pCi/gm.

This standard is based upon a consideration of the radium-radon exposure pathway. In its discussion, EPA relies upon two basic assumptions. These are that (1) indoor radon decay products in excess of 0.01 WL pose an unacceptable health hazard, and (2) radium-226 soil concentrations of 5 pCi/gm or greater will result in radon decay product levels in structures in excess of 0.01 WL.

The conclusion that indoor radon decay products in excess of 0.01 WL pose an unacceptable health hazard is highly questionable. A significant portion of structures in the U.S. exceed the proposed limit of 0.015 WL even though they are not associated with tailings.

Radon flux rates for a given Ra-226 soil concentration are very sensitive to a variety of conditions including, for example, grain size distribution, moisture content, compaction, and barometric pressure. The indoor radon decay product levels are also dependent on the type of building materials and configurations.

Thus, establishment of a correlation between radium-226 in soils and indoor radon levels is precarious at best. If the radium-226 standard is founded on indoor radon decay product concentrations, some assessment of the depth/exhalation phenomenon is needed.

EPA relies on two publications for its conclusion that a 5 pCi/gm radium level correlates with a 0.01 WL. One is the Healy and Rogers report which makes a preliminary study of radium-contaminated soils. The report argues, it does not conclude, that indoor radon decay product concentrations of 0.01 WL might be expected for soils with radium concentrations of 1 to 3 pCi/gm. This is not a reasonably scientific foundation for standard setting.

EPA also relies on the NRC Staff Technical Position on Interim Land Clean-up Criteria for Decommissioning Uranium Mill Sites in the NRC Draft GEIS. EPA uses this document to conclude that 3 to 5 pCi/gm of radium can cause indoor concentrations of 0.01 WL. However, the table indicated radon levels inside structures on land averaging 5.0 pCi/gm Ra-226 would range anywhere from 0.0024 to 0.04 WL units. This wide range of radium values points out the questionable validity of the use of a radium-226 standard for remedial action.

A comprehensive analytical study of radon flux rates that can be anticipated under conditions typical of uranium mining conditions in the western United States has recently been completed by industry. This was provided to EPA as part of AMC testimony on EPA Resource Conservation and Recovery Act Regulations (Statement of S. Baker on March 9, 1979). The study shows that structures with average ventilation which are situated on reclaimed waste rock deposits having Ra-226 concentrations averaging 20 pCi/gm to infinite depth will normally exhibit radon decay product concentrations on the order of 0.01 WL. Similar structures situated on deposits having Ra-226 concentrations averaging 20 pCi/gm near the surface and up to 70 pCi/gm below to infinite depth are shown to exhibit decay product concentrations no greater than 0.02 WL. From this study, it can be seen that a 5 pCi/gm cut off used to control indoor radon decay product concentrations to 0.01 WL is unreasonable.

The health risk posed by tailings material on open land has not been assessed. The highly tenuous correlation of radium-226 in soils with indoor radon decay product concentrations makes the use of such correlation unreasonable. No discussion of alternate indoor radon controls has been made. No need for the 5 pCi/gm radium-226 standard has been shown.

Nature exhibits an extremely wide range of environmental conditions. Inadequate consideration has been given to the practical problems associated with the implementation of the proposed standard. Current field instrumentation cannot detect radium-226 concentrations in the specified layers. There would be no assurance that all areas contaminated by tailings in excess of 5 pCi/gm would be identified. Another problem is how to attribute various radium-226 levels to tailings contamination. Considering the wide range of radium background concentrations in the western states and that there has been no background survey, it will be difficult to determine whether some areas exhibit radium-226 levels in excess of 5 pCi/gm due to tailings contamination or because of the presence of natural pockets of high background levels. Verification that every area of greater than 5 pCi/gm radium-226 levels attributable to tailings has been detected and cleaned-up to standards will be impossible to achieve.

Not only are the practical limitations of the field instrumentation and verification process not considered, the problems inherent in existing analysis techniques for radium-226 are ignored. Present techniques are slow and time-consuming and lack the precision necessary to measure low concentrations accurately.

Since the radium standard is not directly related to health effects, an assessment of alternative bases for standards should be considered, for example gamma flux. A flexible standard based in part on local background concentrations may be another potential alternative. Under the proposal, dirt removal will be required to comply with the standards. Reclamation standards should be considered. Such alternatives could provide the degree of health protection desired for the public at a much reduced cost.

D. <u>Radon Emanation Rate</u>

EPA has proposed that radon emanation from inactive tailings piles not exceed an average annual rate of 2 pCi/m^2 x sec. EPA's justifications for such a standard are that it will return radon flux to levels near background; that the cost of meeting the 2 pCi limit will be only 10% more than meeting some less stringent level of control; and that it will avert 200 lung cancer deaths per century.

To begin, the assertion that 200 lung cancer deaths will result if no remedial action is undertaken is erroneous. Better data (Evans, et al.) indicate that no more than 30 per century will occur.

EPA's stated objective of returning radon flux to levels in the range of natural background is not related to health risk and therefore is not an appropriate basis for a health standard like the proposed inactive site standards. As stated above, EPA's authority under the Uranium Mill Tailings Radiation Control Act is limited to proposing standards that are health based. The same holds true for the statement that the 2 pCi standard is reasonable, because it will only cost 10% more than a standard of 10-40 pCi. Ten percent of several hundred million dollars is an absurd amount to spend if it results in very little benefit. Requiring such an unnecessary expenditure violates Executive Order 12291.

The inactive site standards must be based on a reasoned evaluation of health risk. They must also be cost-effective. Even if EPA's estimate of health effects was accurate, it is unreasonable to spend hundreds of millions of dollars to prevent the equivalent of 2 estimated deaths per year from lung cancer -- a number that is totally indistinguishable from the thousands of deaths attributed to lung cancer every year in the United States. The EIS estimates that a radon exhalation limit of 2 pCi will prevent 99.6% of the 200 health effects that would occur each century if the piles were left uncovered (EIS, p. 6-7). The 1978 Uranium Mill Tailings Radiation Control Act does not mandate total elimination of risks.

As indicated by Evans, et al., the risks associated with radon emissions from tailings are insignificant. On this basis, AMC proposes that no radon flux standard should be included in the inactive site standards. This is consistent with the Uranium Mill Tailings Radiation Control Act which requires a showing of significant risk by EPA before it issues regulations.

E. Indoor Radon Daughter Concentrations

The 0.015 WL remedial action level for habitable buildings was promulgated without public comment by EPA as an interim cleanup standard. This interim standard is at distinct variance from the remedial action level set for persons residing on Florida phosphate lands, namely 0.02 WL, including background. The citation for the source document recommending 0.015 WL in the Draft EIS is AR 79, p 4-40. The reference citation was not accepted by peer review for publication.

The EPA is using a risk factor estimate of 10^{-3} per WLM for radon exposure related health events which is not generally accepted. The most scientifically based risk assessment factor is 10^{-4} per WLM as an upper bound of the risk (Evans, et. al.). This upper bound value is based on meticulous review of all USA and Czeckoslovakian uranium mining epidemiologic data. Based on these data, there is no proper scientific basis for selecting the unnecessarily restrictive value of 0.015 WL for the indoor radon exposure limit, including background values. In the draft EIS, the large uncertainty surrounding the risk estimate for radon related health effects is freely admitted and casts doubt upon the probity of extending the results to the general public.

NRC's 10 CFR 20 recommends limits for nonoccupational radiation exposure a level of one-tenth the occupational exposure limit, or 0.03 WL. This is a more rational level and has wide acceptance in the scientific community. The Surgeon General recommended 0.05 WL as an upper limit for cleanup in Grand Junction buildings contaminated with uranium mill tailings.

U.S. Radiation Policy Council advises that a generic study of the frequency distribution of radon exposure in structures should be made a necessary first step before Federal control actions on more than a local, problem oriented level are contemplated. We believe EPA should delay setting such a standard and rely on the Surgeon General's guidelines of 0.05 WL upper limit for cleanup of potentially contaminated habitable structures near inactive tailings areas.

F. Groundwater Contamination

AMC has a number of specific concerns with respect to the ground and surface water standards. EPA has not given any consideration to the existing or anticipated uses of the surface and groundwater it is proposing to regulate. Because of the shallow depths of many uranium ore deposits, it is not uncommon for the original quality of water where a tailings disposal site is located to not be suitable for drinking water. Rather than acknowledging this, the proposed regulations set out to treat virtually every water bearing formation or water body as if it were a drinking water source.

The proposed regulations require that seepage not cause concentrations of selected elements in groundwater to exceed the maximum contaminant levels for particular substances under the National Interim Primary Drinking Water Standards. This prescription would in many cases make little sense. For example, if the initial water quality of an aquifer underlying a uranium mill tailings pond renders it suitable only for industrial use, what purpose would be served in prohibiting a slight increase, or indeed a large increase, in the concentration of one of the listed substances?

It appears arbitrary to lift a set of standards from one statute applicable to drinking water supply and apply it to another statute intended to govern groundwater absent to compelling rationale. Such a rationale is, however, lacking anywhere in the DEIS.

Certain criteria listed in Table A appear to be unduly restrictive. These criteria will commonly be exceeded by normal background conditions.

The suggested limit of 10 pCi/liter for uranium does not appear to have any sound scientific basis. Guidelines for uranium in water have been promulgated by federal, state, and international agencies. NRC, based on chemical toxicity, proposed 30,000 pCi/l for workers which calculates to 3000 pCi/l after dilution. The Wyoming Department of Environmental Quality has adopted 5 mg/l or 3400 pCi/l. Colorado Department of Health suggests 10 pCi/l is too restrictive. The ICRP (Publication 30-1979) established an annual intake for workers based on radiological effects equivalent to 14,800 pCi/l for the public. This may be conservatively low because the ICRP model may overestimate the radiological bone cancer risk factor. Again, these standards must be health based under the Uranium Mill Tailings Radiation Control Act. EPA has not established the health need for these groundwater standards.

IV. <u>The Cost of the Proposed Standards are Underestimated</u>

A. <u>Costs are Ignored</u>

In Chapter 6 and the cost estimates in Appendix B of the DEIS, AMC notes numerous omissions and inadequacies. Costs for engineering, field supervision, or contingencies are not considered. Provisions for reclaiming the land from which topsoil, cover, or riprap is obtained are not considered. To purchase topsoil may be impossible, as most states require saving topsoil for reclaiming the land from which other cover material is borrowed. If the tailings are moved to a new location, the topsoil at the new location will have to be excavated and vegetation established to prevent erosion during the storage period until the tailings are moved. Riprap is not a readily available material, nor is it free. It will probably have to be quarried, and we see no costs to cover this. In some locations, a suitable clay at a nearby location is nonexistant or is very scarce; or if available, only at a considerable distance. These costs are not considered.

The unit costs in the DEIS were compared with costs being experienced in actual tailings dam reclamation work. The industry experience in some instances compares favorably with the costs in the DEIS; however, for below-grade excavation, transportation, synthetic liners, and soil and vegetation cover, the industry figures are 2.5 to 3 times higher.

Te evaluate the effect of the estimating methods as well as the unit costs, estimates for two cases comparing EPA and industry figures were made. For Option 2, reclamation in place, industry costs were from 1.8 to 2.7 times higher than EPA's.

By similar comparisons for moving the tailings to a new disposal area (option 3 in the DEIS), the industry figures were from 2.7 to 2.9 higher than the EPA estimates.

The EPA estimates do not include the costs for reclamation of the borrow sites and makes no provision for costs of cleanup around the mill sites, remedial action at offsite locations where tailings may have been used for fill material, survey and decontamination of used equipment, burial of contaminated equipment, demolition and disposal of buildings or reclamation of the mill site.

B. Total Cost of Project

AMC believes the total remedial costs for the 24 inactive mill sites which EPA estimates at \$200-300 million (page 5-3 and 9-8 in the DEIS) will more likely approach \$1 billion if the proposed EPA standards are adopted.

We have estimated the total cost of the 24 inactive mill sites assuming 17 are reclaimed in place and 7 are moved to new below-grade disposal sites (Table 2-4, pages 2-16 and 2-17 in DEIS). Based on EPA estimates, the total costs will vary from \$50 to \$200 million. This is the cost for tailings reclamation only and does not include many other remedial actions required as mentioned earlier. Industry estimates that the total tailings reclamation cost could range from \$140 to \$450 million.

C. Cost-Benefit Considerations

The thicker the cover, the higher the cost, and the less radon release from the covered tailings. The DEIS states that "...reducing an uncontrolled radon release rate of 450 pCi/m^2 --

sec to $10pCi/m^2$ -- sec would avert 98% of the potential effects of radon emitted from the uncontrolled pile." Taking into consideration all the inactive piles, this would theoretically reduce the 2 premature deaths per year to 0.04 per year.

Using a more recent estimate of risk from exposure to radon-222 as proposed by Evans et. al., the 90% reduction of radon would reduce the premature deaths from 0.3 per year from the uncovered piles to 0.006 per year. This would be equivalent to a cost of $2.3 million (EPA) to $17 million (industry) per premature death averted per century. This value is, of course, absurd.

Reducing the radon by approximately 80%, or to an emanation rate of 100 pCi/m^2 x sec, would reduce premature deaths from 0.3 to 0.06 per year at a total cost of $50 to $360 million. Even this calculates to be $2 million (EPA) to $15 million (industry) per premature death averted per century, still an unreasonable figure. The inclusion of a radon emanation limit in the proposed standards cannot be justified on health effects.

In summary, we believe the total cost for the entire remedial action project designed to meet the proposed EPA standards will likely approach a billion dollars. This will result in a cost-benefit ratio which, using even the lowest figures, is greatly out of reason. Less restrictive standards will greatly reduce costs and still insure long-term stabilization along with reducing health risks which, even without controls, are not now at unacceptable levels. In fact, for health effects alone, the expenditure of $300 million to $1 billion, whatever estimate one uses, would be far better spent on many more critical risk avoidance measures.

Because Congress and state legislatures must approve the appropriations for all remedial action, it appears prudent in these times of budget constraints to develop standards which are reasonable and which may be accomplished at the lowest possible cost. The magnitude of costs required to meet EPA's unnecessarily strict standards may jeopardize the entire program.

BEFORE THE

ENVIRONMENTAL IMPROVEMENT BOARD

STATE OF NEW MEXICO

RE: Proposed Amendments to)
Radiation Protection)
Regulations.)

TRANSCRIPT OF PROCEEDINGS

BE IT REMEMBERED that on to-wit, the eleventh day of June, 1981, this matter came on for hearing before the New Mexico Environmental Improvement Board, in the Nambe Room, Convention Center, Albuquerque, New Mexico, at the hour of ten forty-five o'clock in the forenoon.

* * * *

APPEARANCES

FOR THE ENVIRONMENTAL IMPROVEMENT BOARD:

MR. GEORGE HENSELY, Chairman
MR. ROY S. WALKER, Member
MS. BETTY HYATT, Member
New Mexico Environmental Improvement Board
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MR. JEFF BINGAMAN
Attorney General
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By: Mr. Herbert Silverberg
Assistant Attorney General

FOR THE RADIATION TECHNICAL ADVISORY COUNCIL:

MR. PETER O. STROM, Member
MR. JAMES E. CLEVELAND, Member
MR. CHARELS M. THOMPSON, Member

* * * * * * *

ROBLEY EVANS

was called as a witness by the U.E.S., and having been first duly sworn, testified upon his oath as follows:

DIRECT EXAMINATION

BY MR. CROUT:

Q Doctor, if you could briefly describe the position you held in the educational field, and what areas of expertise you did teach and study in that area.

A Well, I'm a professor of physics emeritus from Massachusetts Institute of Technology, where I was a faculty member from 1934 to 1972. I've been, in terms of radiation sa I've been president of the Health Physics Society, the national society that deals with radiation risks. And I've been national president of the Radiation Research Society. I'm a life member of the National Council of Radiation Protection; received my -- I began publishing on the effects of alpha rays on humans in 1933, and I'm still publishing. I don't want to use up a lot of time on telling --

Q Yes.

A You're looking at Who's Who in America or whatever.

Q Have you received any medals or awards from the American Medical Association?

A. Yes.

Q. And what were those?

A. I received the Hull Gold Medal award for the study of radium and the effects of radium on humans.

Q. And are you a member of councils on radiation protection?

A. Yes, I am.

Q. And what is that council?

A. That's the National Council on Radiation Protection and Measurements.

Q. And in terms of the number of papers you have published over the years, approximately how many would have been published?

A. Oh, it's well above two hundred fifty. Somewhere between there and four hundred. I don't keep track.

Q. And are most of those in the area of radiation and its effects?

A. A good many of them are, but they are in the wide field of statistics, epidemiology, nuclear physics, geophysics.

Q. In terms of the regulations that this board is hearing on at this time, you have testimony that you

you would like to present concerning them?

A. Yes. I have comments which I thought would be helpful to the board in making its decision.

Q. If you would make them.

A. Well, I think the first thing to recall is that radiation, which from the media gives us some worries, is a thing that we all live with all the time, and all of our ancestors have. And if you consider this room, for example, the radiation which is obvious to everyone is the visible light from the illumination. But there is also ultraviolet light in here from these lights, and there is infrared.

And you know that if you set up a portable radio, you pick up a number of radio stations. This is radiation. These are electromagnetic radiations, the same type that we'll be talking about later.

You know that there is -- there are T.V. signals in here. You can set up T.V. sets and pick up radiation. There are satellite signals you could have here. You can get Kirtland Air Force Base material in this room. This room is full of radiation.

It's also full of cosmic rays. And at the altitude of Albuquerque, it's giving each of us about fifty millirem per year from cosmic radiation from outer space. It's also giving us local gamma radiation from the materials of construction and from the ground to the tune of about forty-five millirads per year.

Each of us has a certain amount of body muscle. In the male, it's about forty percent. In the female, it's about twenty-three percent, and potassium is the main constituent, a main constituent in muscle. Potassium is a radioactive nuclide, so each of us is a source of radiation.

And if you are afraid of radiation, you should sit far apart, and don't sleep in the same bed with anybody else, and stay out of crowded elevators, because each of us is a source of radiation, which is very easy to detect with modern instruments, and can quantify it with great ease.

There is also in this room, radon, as there is everywhere, a radioactive gas which has been described in various ways. It is an alpha emitter with a half period of three point eight days. A half period, of course, means the time required for half of the radioactive material to have disintegrated. And in two half periods, there would be a quarter level; and three half periods, there would be an eighth of the original amount level consumed.

The daughter products, the decay products of radon are also in this room, and these are being inhaled by all of us. We all have a certain number of working levels of radon daughters in this room, which we're all inhaling and which we inhale at home and out on the street.

With respect to units, there has been various questions in the past day-and-a-half that I've listened to about millirems and millirads. And I don't think you even got to milli-Roentgen and the grey unit and the Severt unit have not even been mentioned, but -- and these units, the millirem in particular, and the millirad, would be the most likely units which would enter any discussion or questions that you might want to ask me.

And, of course, milli simply means one one-thousandth of. And a rem is left over from World War II days. The Roentgen was the original exposure unit named after Professor Roentgen. And the new unit which came in informally during World War II was a rem, Roentgen equivalent physical. Then there had to be added to that rem, which means Roentgen equivalent, man, mammal or mouse, which are you? So this is the rem unit, and it's a unit of modest size, but the doses which we all receive are so small that usually, it's discussed in terms of millirems; that is, thousandths of a rem.

For guidance, I've already given some indication of what you're getting. You're getting fifty millirems. And in the case of cosmic radiation, the rad is about the same as a rem. And for gamma rays, a rad is about the same as a rem.

Those of us who are flying in and out of Albuquerque receive a half a millirem per hour at jet altitude. That's just one of the decisions that we all make.

We found out yesterday that a curie is a unit of activity named after the Curie family. And we had to redefine it after World War II. And I was on the international commission that redefined the curie unit. And we had quite a bit of trouble, I might say, with Marie Curie's daughter, Irene, but eventually, we had the three point seven times ten to the tenth disintegrations per second, which means a curie. And the pico curie is what you're talking about here. Pico means one million millionth ten to the minus twelve. So much for simple things of that type.

The radioactivity in nature is everywhere. Our modern instrumentation, oh, even twenty years ago we could measure the radium content of anything in this room; your necktie, your jacket, Mrs. Hyatt, anything at all. There is a measurable amount of radium in it, because instrumentation is very sensitive, and because ratioactivity is completely widespread, it's all over everywhere. There are, in nature, forty-five naturally occurring radionuclides, radioactive materials found in nature.

With respect to radium and uranium in nature, an interesting guideline is that it is, as I say, everywhere. And on the average per square mile of backyard or highway or prairie or desert, per square mile to a depth of one foot, there is six tons of uranium and two curies of radium-226.

So it's everywhere, and there is a lot of it. Each person in this room has a body burden of about a hundred pico curies of radium-226. And you also have a hundred and thirty-five thousand pico curies of potassium-40. So they are pretty good radioactive sources.

Your eating and your diet every day, about two pico curies of radium per day in the ordinary diet.

Now, with respect to radon, which, of course, is the first decay product of radium, the unit of measurement commonly used which leads to the working level of the unit is a hundred pico curies of radon per liter. It s a gas, as has been said so many times, but it isn't a whole lot. It's less than two million atoms of radon per liter for a hundred pico curies of radon per liter. And most of the numbers that you've been talking about are one pico curie per liter and so on.

In such air, the attenuation, the dilution, the amount of radon is such that there is about one atom of radon. This is that air with a hundred pico curies of radon per liter-- there is less than one atom of radon per ten to the fifteenth atoms of nitrogen and oxygen. That means one atom of radon per thousand million atoms of oxygen and nitrogen in the air.

It's partial pressure radon. Partial pressure in terms of barometric pressures is ten to the minus sixteenth of the atmosphere, but is zero followed by a decimal point followed by sixteen zeros and a one -- fifteen zeros and a one.

So radon is not a gas that you can see, or that's going to create a wind or a breeze or anything like that. It's a few atoms at a time. The radon itself, as I think has gradually come out in the discussion, is relatively innocuous in comparison with its so-called decay products or daughter products. And all of those words mean the same thing. These are the radioactive decay products of radon. They are radon A, B, C, C prime, the short-lived ones, and they are not gases, they are isotopes of solids. They are isotopes of lead in plutonium so that the daughter products, when they hit anything such as the wall or the table or the inside of your lung, they lie down and stay there.

They are not a gas. If you inhale the combination of radon and radon daughters, you'll exhale the radon and you'll keep the daughter products. Not all of them, but about twenty-five percent of them, if you're a normal, breathing human, but all of the health effects relative to radon in the lung.

I don't know how the stenotypist can put in quote marks. All of the health effects of radon so-called is in the lung, is not from radon but from radon's daughter products, so-called radium A, radium B, C, and C prime, and is of common elements lead embezzlement from plutonium.

At one working level in air, which is a measure of the amount of daughter products present, that's the amount of daughter products which would be present at full radioactive equilibrium with a hundred pico curies of radon per liter. And it means that there is one atom of daughter product per ten to the seventeenth atoms of oxygen and nitrogen, so it's extremely diluted.

You also need to recall that the -- that radioactivity being everywhere is of geophysical importance. The radioactivity when spoken of is six tons of uranium per square mile, to a depth of one foot. And the corresponding amount of radium generates heat, and the earth's internal heat is due to radioactivity in the earth's crust and in the underlying basaltic and inner core layers of the earth.

These give up about ten to twenty-one per year. And all of the energy is available for -- all volcanoes and all earthquakes are due to energy from radioactive decay inside the earth.

The earth's surface is not cooling down, it's heating up because of the radioactive decay in the interior of the earth and the long travel time of a therma. wave and cervical cord. And it's going from the center of the earth out to the earth's surface.

One of the decay products, one of the -- not a decay product, the -- the commission, the radiation which is spoken of this morning, radon emits alpha rays, alpha rays such as radium. The alpha ray is a he.ium nucleus. And as soon as it's stopped, which is -- it's stopped by a piece of paper, it cannot penetrate the piece of paper.

So that all of this radioactive decay gives rise to an accumulation of helium. And this is why we have helium in gas wells, but in the places where there isn't this geochemical concentration of helium it's interesting to note that the ordinary radioactivity of the earth's crust is such that the helium content of one cubic mile of earth is sufficient to do this.

So radioactivity is everywhere, and radiation is everywhere. We have lived with them, our ancestors have lived with them, and our children and our grandchildren and our great grandchildren will. The effects of radiation on materials of construction and on living things is probably the best studied of all environmental subjects.

Now, about low-level radiation, which is a media phrase lately, there are at least three areas in the world where a group of people have lived for a considerable time, like five hundred to a thousand years, with considerable inbreeding in China, in Brazil, and in India, in areas where the background radiation is two to three or more, four or five times as great as it is for the rest of us.

So we say we double the background radiation of us, what will that do to us? The answer is nothing.

That is, the effects have been carefully studied in China and in Brazil. It's on the east coast of Brazil, just north a mile from the Amazon; and in India, a colony, a group just south of Bombay, about fifty miles. These have been very carefully studied, and there is -- there are no radiobiological effects. They do not differ in any way.

For example, in India, from the population at Bombay, the same effect in China. Norman Frigerio, the late Norman Frigerio of the Aragon National Laboratory and his colleagues, studied the effect of variations of background radiation in the United States. You can take an average figure for the background radiation in New Mexico, and that will be different for the average background radiation in California or in Massachusetts.

The numbers will, for the forty-eight continental states, range from a hundred millirem per year to two hundred fifty millirem per year. So you've got a range of two-and-a-half.

Then you can take the cancer statistics, not only all cancers, but the individual types of cancers, leukemia, breast cancer, whatnot. And you can plot these, plot the cancer incidence as a function of the background radiation to which all citizens are exposed. And the interesting thing is that without any question at all, statistically, the lowest cancer incidence occurs where the radiation background is highest. The curve definitely drops down, there is no question about it. These are the data Frigerio and others presented quite widely. And there is a brand new paper in the current issue of Health Physics from an entirely different group headed by Richard Hickey of the Horton School in Pennsylvania who's finding the same thing.

If one belived this, one would have to say that a small amount of radiation is a highly beneficial thing. There is no question that if you live in a state, I think, with high background radiation, you're living in a state in which the citizens have a low cancer incidence compared with the rest of the United States. The effect is indisputable.

There have been a few instances of very high levels of radiation in which groups of persons have been harmed. One of the earliest of these, of course, is the radium dial painters back in the days of World War I. And this is a field -- these girls swallowed radium by taking a brush, and many of them developed bone cancers.

From 1933 to the present time, this has been one of my principal scientific activities, and I've studied more than a thousand such persons, and have quantified the dose that they got and the medical consequences. I can assure you that the relationship is not the linear nonthreshold, and that the alpha radiation is high L.E.T. radiation.

There is absolutely no question that there is no linear nonthreshold model, which can conceivably fit the data. The statistical odds against the linear nonthreshold model in this case are one in five million. This has been published. If you'd like the reference, Radium in Man, 1974.

The second group are the uranium miners, particularly originating in the Sneberg and the Amconof mines in Bohemia, and Sacksonie in the previous century. Those data are summarized in a paper in 1940. And the first suggested radon and thoron permissible values for use in the United States.

In the wild west days of uranium mining in this country, when we were at war, active war, and then in cold war, the question arose as to whether our miners might be being exposed to something that could produce lung cancers.

Duncan Holliday was a central figure in all of this. And later, a young man joined him called Victor Archer. I worked with Duncan Holliday on these matters. We first went into the mines together in 1954, and Victor Archer came out about six or seven years later and undertook to compile the data, but there are examples at very high levels.

Now, those persons, the miners, who -- as was said this morning, we're still seeing new lung cancers which are the result of exposure twenty years ago, long before the present standards of four working level months per year since those were put in, as you know from the on-going study of the uranium epidemiology study here at the University of New Mexico, the lung cancer incidence among new miners since 1961 is nil. So much for background.

Now, with respect to specifics which are relevant, directly relevant to the issues of this hearing, let's talk about radon flux and radon dispersion. The radium which is in all rocks and gravel and sand and dirt is producing radon at a constant rate. That's its first daughter products.

So that underground where there is radium, as there is in all the rocks, radon is produced at a constant rate. The rocks, of course, have voids between crystals of grain. The radon part of it gets out of crystal grain, and as a gas, sits there in the interstitial between the grains. And then it's a gas, and you see how terribly diluted it is. And it moves up and it moves down towards the center of the earth, and then it moves sideways.

Some of it which comes up toward the surface of the earth eventually makes it before having decay, and is exhaled from the surface. So at the soil air interface, there is a flux of radon.

The normal, average United States radium content of soil is one pico curie of radium per gram of soil. The normal radon flux produced by this radium is one pico curie of radon per square meter, about a square yard per second. In a typical high-level tailings pile, and you see the uranium ore is simply a geochemical, in which this universally present uranium has by some chemical means, through underground waters or others, been concentrated.

And if it's concentrated by a few hundred or few thousand fold, it's worth mining. And then the rest of the uranium dependent industry follows on from there. But if you take the high -- a high number, the flux from typical inactive, unstabilized uranium tailings pile is six hundred and forty pico curies of radon per square meter, six hundred forty times the ground average.

This means that from one acre of tailings pile, there would be six hundred forty times as much radon flux from one acre of tailings pile as from an acre of ordinary land; or from one acre of tailings pile, it would be the same radon as from six hundred forty acres of ordinary land, but that's a square mile.

So you have a handy-dandy rule of thumb which is that the radon flux from an unstabilized uranium tailings pile, one acre tailings pile, corresponds to the radon flux from one square mile of ordinary countryside, pasture, prairie, desert or mountain. So it makes it very easy.

Now, in the United States, among the inactive piles, there is one thousand acres of tailings with -- some of which is stabilized. I'm going to take the limiting case that none of it is stabilized. The radon flux from the tailings pile, it comes out as radon, out of the surface of the ground. There are no daughter products with it because the daughter products are solids. They are down in the ground, and it's only the radon gas which comes out. It, therefore, has no daughter products, and the working level value is zero.

You have to wait, and we have a concept which is called age of air. You have to wait for the ingrowth of the daughter products. When these daughter products grow in for the first thirty, forty or fifty minutes, a little bit more slowly than linearly with time so that in four or five minutes, you get less than, oh, around eight or nine percent of the equilibrium daughter products will be built up. And this is time enough for a five or six knot wind to carry the radon from the pile, a half a mile away from the pile before the radon daughters appear.

In terms of a question asked of a witness yesterday as to what would be the levels on top of a tailings pile, the answer should have been the working levels are zero, or substantially zero, because the radon has just come out of the ground, and it's being blown away and it doesn't have any time yet to develop its daughter products. And it's only the daughter products that are bothersome. So the best place to be, if you want to be away from the daughter products, is right in the middle of the pile.

Now, the dispersion then of the radon which comes from the pile, it's blown in the winds. It diffuses by turbulents. It -- which is a vertical distribution, which under some studies is expedential, but not under all studies. And a great deal of work has been done. The master work, the best of it, is by Public Health Service and A. E. C. people in 1967 and '68, Shearer and Claude W. Sill.

And their paper resulted in a Public Health Service publication, and in a refereed paper in the open literature, Health Physics, Volume Seventeen, page seventy-seven to eighty-eight, 1969. They studied the radon -- not radon daughters, but radon itself, at a large number of sampling stations in four cities; Salt Lake City, Grand Junction, Monticello and Durango. They set up sampling devices which constantly sampled the air three feet above ground level, a little more than that, five, I guess, approximately, breathing level for forty-eight hours, continuously, and collected that sample.

They did that every three weeks for a year, so as to get an annual average value. They found that at any distance equal to or greater than one-half mile from any of these tailings piles, no radon from the tailings pile could be found. The values were back to the background for the town. That is, the radon in the air is the same at a half mile as it is at twenty miles in, for example, Grand Junction.

And Shearer and Sill wrote explicitly, the tailings at Grand Junction are not affecting the atmospheric radon concentrations beyond a distance of point five miles in the prevailing wind direction. At the other three study locations--see, that means Salt Lake, Monticello and Durango, at the other three study locations, the effect of tailings is not observed at distances greater than one quarter to one half mile. So that so far as radon daughter hazards from radon eminating from a tailings pile is concerned, if you go beyond a half mile from the pile, you can forget it. There is no effect from either these large piles -- the Salt Lake City pile is more than a hundred acres of very rich material, and has activities about twice the model mill considered in the new regulation.

This set of measurements was repeated at Grand Junction by E. P. A. workers in 1974 to '75 by David Duncan and others. And their measurements, interestingly enough, came out to agree completely with Shearer and Sill for Grand Junction, except for four stations which they inadvertently used which had local contamination where people had used tailings from the pile and taken it to -- the one was a chemical company, the Smith Chemical Company, the L.S.D. warehouse. A state police building has tailings in it. And, of course, you can't set up a valid station and make those measurements, but the agreement then is excellcnt, and these measurements can be relied on.

I was peripherally involved in the measurements in 1967 and '68, and I can assure you that I can personally certify that the measurements were accurate, and that the method of collecting the samples was satisfactory.

And, of course, in doing modeling as the N.R.C. and the E.P.A. and everybody else has to do, the models do not give the same distribution of radon in the air as a function of distance from the tailings pile as is observed in the field.

Now, when the model and the experimental results disagree, it is the experimental results which are correct. And one must find the model, if possible, which agrees with observations. So far, as far as I know, nobody has found such a model. They all -- all of the models that I've studied overestimate the radon concentration at close-in distances, and by amounts as even clearly done here in new reg--at page-- well, here's radon-222 in there on pages G-33.

And from this tailings pile, which is half --

about half the radon release as Salt Lake City, one is giving at one kilometer distance, that's about point sixths of a mile, one pico curies of radon per liter.

Sill and Shearer had two measurement stations at point three and point four miles from that very pile, and their values were about four pico curies of radon per liter. It would have been impossible, experimentally, to have overlooked the presence of one pico curie on top of a background of point four, if the model had been correct. The model is simply not correct.

This, of course, means that health effects for persons living close to a pile which was discussed yesterday, are always overestimated if the radon and working level values are based on models. One needs to go to the actual data.

Now, we said that an acre of unstabilized, inactive tailings is about equal in radon flux to one square mile of ordinary land. There are variations, of course, from this. The smallest I know about is around a half of a pico curie of radon per square meter per second, and up to five or so in my experience. But my very good friend, Doctor John Rundol at the Aragon National Laboratory is doing this kind of thing now in houses containing unpaved crawl spaces around Illinois.

And he's reporting to me open referee literature values as seven pico curies per square meter per second, just from ordinary dirt underneath the house.

Now, Salt Lake City has been -- that tailings pile, since it is near a large metropolitan area, has come in for a great deal of discussion. It's a hundred acres. That means that its radon release, by the handy-dandy rule of thumb, is about the same as from a hundred square miles of ordinary land.

Now, the great Sale Lake, which is right in the front yard of Salt Lake City, had a change in its water level of eleven feet between 1966 and 1976, in that decade. This cut off eight hundred square miles of land which were covered by water, and therefore, the radon flux was eliminated. So this natural process in Sale Lake City reduced the radon flux in the vicinity of Salt Lake City eight times as much as was the radon flux from the tailings pile which people were so concerned about.

I'm saying that nature's ordinary variations are vastly greater than the kind of radon fluxes that are coming from even untreated, unstabilized, wide-open dry tailings piles.

On the national scene, the thousand acres of inactive ur=nium tailings piles is the equivalent then of a thousand square miles of land. Well, how much is a thousand square miles? It's a square thirty-two miles on the side, or it's a circle with a radius of eighteen miles. It's less than one three thousandths of the area of the forty-eight continental United States.

Now, we're talking about the radon release from all -- all twenty-two or twenty-four of the unstabilized piles. There are, in the United States, fifty-five thousand square miles of inland water, lakes and rivers. A two percent change in the area of the inland waters changes the national radon flux by more than all of the inactive, unstabilized tailings ponds.

You all remember the story of the little Dutch boy who put his thumb in the dike. I hope you all remember it. The Netherlands has gradually been diking off the Zuyder Zee, and making land out of it. To date, they have created three thousand square miles of new land. The radon release from this is three times the radon release from all of the unstabilized, inactive uranium tailings piles in the United States. Who is going to say that the Dutch boy diking off the Zuyder Zee have introduced a horrible lung cancer hazard in western Europe.

There are a great many other points which could be made, but I know our time is short. It should be pointed out that plowing of a field changes the radon emission. It turns the soil over, and you've got radon which was at high level beneath the surface.

It's the same as in a mine after blasting, growing crops brings radon through the roots from an area of high radon concentration. And burrowing animals, gophers and whatnot, live in a high radon and radon daughter concentration, which is about a thousand times what you and I live in.

Now, these burrowing animals are not noted for being killed by lung cancer, but they are getting a thousand times what any of us get, or could get from any of these tailings piles. So that what I'm saying is that the total radon released from all the inactive, unstabilized uranium tailings piles is a minute fraction of the variations produced by meterological conditions and agriculture in the total radon released by natural processes from all land areas. The level of radon decay product exposure at a distance is greater than a quarter to a half a mile, is a minute fraction of the range of fluxations of the range of background in the area.

And under the A.L.A.R.A. principal which -- was voiced yesterday morning, there is no substantial reason to reduce that exposure further. Lung cancer risk factors have been discussed, and has been a pyramid of inaccurate information which, if time remains, I'd be glad to go into. But just to say that I'm delighted that Doctor Branagan and others are beginning their studies in this field, but there is a long ways to go.

The authors of the B.I.E.R. III section, which was quoted this morning, the authors of that section was held confidential. We don't know who it was. It was not subjected to peer review. It is a very bad section. It has many errors of fact.

The work of Archer and of Axelson has been mentioned this morning. That work was a complex thing, but together, by Vic Archer, Ted Radford, and Axelson, in early 1938, combining U. S. data on lung cancer among miners and Czechoslovakian and Canadian data, and Swedish data with very poor regard to confounding variables. The paper was submitted -- it originally had five authors, and those of us who have recently published the paper which Doctor Schiager spoke about this morning, a group of senior specialists from four countries, had all of those manuscripts available at the time of our meeting. We rejected them as unsound, and the manuscript then was converted. I think this is a matter of public record. I don't want to be running anybody down, but I can tell you what the facts are. It was submitted as a paper by Archer, Radford, and Axelson to Radiation Research in 1978, and given peer review and refused out of hand.

You must not put any reliance on this concept that the dose response is any faster than linear. You'd be talking about a dose to the one-half power. We call that a belly-up curve, like that. The pro's statement is that at lower levels, per working level month, the risk is greater than at higher levels. This is simply not so.

The statistical evaluation of the data used in our paper is not based, as was stated this morning, on lung cancer in the 1930's. It is based on the uranium miners, particularly of the United States, and the data collected by the U. S. Public Health Service, including Victor Archer. The Czech data, as is stated, gives a slightly higher risk, but in the case of Czechoslovakian mines, these mines are rich with arsenic and nickle and chromium. And arsenic in particular is known to be a carcinogenic to produce lung cancer. And in the case of Czechoslovakian miners, they are now reporting incidence -- excess incidence of skin cancer.

Now, skin cancer is directly attributable, as any dermatologist will tell you, to the systemic intake of arsenic, so that the Czech data which we kindly said in this article, the Czech data imply a risk about three times as great. The discrepancy is not readily explained, period. That's all we said about it. But that this is the explanation I'm giving you now.

The Canadian data are no good because they are a comparison of a retrospective group of miners with a prospective group of controls. And we've been all through that with the Canadian authorities.

The Swedish data are not useful because they were in mines where they have F.E. 203 iron oxide. And iron oxide is known to accelerate lung cancer from alpha particles in animals.

Doctor Branagan did use, he said in examination this morning, a risk factor of three point six times ten to the minus fourth. That's three point six per ten thousand per working level month. It should be recalled that the data he used are for miners. Miners are not only subjected to other environmental factors, as Doctor Schiager mentioned this morning, such as diesel fumes and dust and whatnot, but also, their breathing rate is quite entirely different from our breathing rate here.

Mrs. Hyatt is now breathing at a rate of about ten liters a minute. And a uranium miner is going to run at twenty, twenty-five to thirty, depending on how hard he's working, so he's taking in a great deal more, you see. And you have to correct for this in terms of numerical values for the population.

All of these things are taken into account in this paper. It was referred to as the paper by Doctor Evans, and I must only say that this is a group of six distinguished senior specialists, worldwide, and it only happens that my name was the earliest one on the alphabet. We're listed alphabetically.

And the second author is John Harley, who was for decades, director of the Environmental Measurements Laboratory of the -- of A. E. C. in New York.

The third author is Wolfgang Jacobi of West Germany of radiation protection.

The next author is Andrew McLean, who is chief of the radiological protection board for the United

Kingdom.

The next one is our good friend, William Mills, who was head of the Criteria and Standards Division of the -- our own E.P.A.

And the last author is C. Gordon Stewart, who was head of the medical division of the Chalk River Laboratories, and in charge of all Canadian radiation hazards works. So you have four nations. And I was going to try to give you an estimate of how many man years are involved here, but most of these people have been at it for as long as radon has been of interest; twenty, thirty, forty years. Nineteen forty -- my first paper was '41, years ago. So this is a -- to obtain a unanimous agreement on a matter of this sort from a group of this type who include all types -- Gordon Stewart treats these matters epidemiologically; Wolfgang Jocobi of West Germany is a modeller, and to get those two men to agree, and the rest of us in the middle to agree, is a fantastic thing.

All it says is that for members of the public, the maximum value, the upper limit value is one in ten thousand; that is, ten to the minus fourth lifetime risk per working level month, and the value may be zero, but it isn't any bigger than one in ten thousand.

Now, the fact that the document is being looked at here, N.R.C. has used a value of three point six times, that doesn't bother me at all. The ballpark is about the same. Drop it by a factor of three or ten or whatnot. I don't think that's worth arguing about. The risks are too high for many reasons.

One is that the radon, radon daughter values close to the pile are too high in the models. The second is that the risk factors are too high per working level month, and there are other factors, but all of these can roll up in a factor of ten or so. That would be really something to discuss in minute detail, if this quantity two pico curies of radon per square meter per second had been based on health effects, but it hasn't.

Therefore, the health effects would, in fact, not be used in determining this suggestion of two pico curies of radon per square meter per second. So the fact that the health risks may be off by a factor of ten doesn't bother me at all.

I do believe that they are about a factor of ten high. Mention has been made of other radionuclides, particularly those that might be in dust from a pile, the Salt Lake City pile. And those of you who lived there know there is a good deal of wind around, has been studied in detail by the Oak Ridge National Laboratory people. And in their document on thorium, ORNL-TM-5251, they report twenty-six separate samples of airborne dust in, around, and on the Salt Lake City pile in a full year of observations. And in every instance, the activity was less than the tabulated maximum permissible concentrations for air, the so-called M.P.C.A.

This is for uranium-226, lead-210, plutonium-210, thorium-230, uranium-234, uranium-235, and uranium-236. So that from the unstabilized, uncovered Salt Lake City pile, with detailed studies, no danger.

What do we got? Forty-five minutes left?

MR. HENSLEY: Doctor Evans, I'd caution you that your -- the cross examination is going to take some time so --

THE WITNESS: All right.

MR. HENSLEY: I know I think I could cover forty-five minutes with what I've got, but mine is for an intellectual level, and not a --

THE WITNESS: Well, let's see if we can close this off.

Gamma radiation on top of a pile was discussed yesterday. The gamma radiation has been measured on top of all these piles. It runs from point two to one millirem per hour, which on a yearly basis, for twenty-four-hour occupancy, would be five rem per year, which is the permissible value for occupational exposure.

Radon, as I've already mentioned, is low. It's around seven pico curies of radon per liter on top of a pile, even with a tiny little breeze and substantially no working levels.

Archer, Radford, and Axelson, I think we've talked about, all right. We take our lifetime risk as a maximum of ten to the minus fourth. This is for populations you see, and it's corrected for breathing rate and cigarette smoking, and all that type of thing.

Well, let me read a couple of r[illegible]s from another document that I've prepared. There are really no significant health problem -- there really is no significant health problem due to radon flux from the unstabilized tailings piles. The piles could be stabilized and provided with a physically sturdy and durable cover of soil and vegetation.

The cover should be designed to prevent erosion and dispersion of tailings by weather, rain, snow, ice, wind, dust storm. Weather resistant cover would be sufficiently thick to reduce the radon flux by probably a factor of at least ten; that is, from a nominal six hundred forty pico curies of radon per square meter per second to the demand of sixty pico curies of radon per square meter per second.

And I know of no radiobiological reason for any further reduction, provided that habitable structures are excluded from the immediate area of the pile.

We've had estimates. I believe the estimate decided on yesterday was six lung cancer deaths in the United States, Mexico, and Canada. Was that a figure you folks gave per year on a basis of your modeling?

DOCTOR SCHIAGER: I believe that's correct.

THE WITNESS: I think that's right. If you drop that -- now, that six per year, the lung cancer death rate in the United States is ninety-two thousand per year, like a hundred thousand. If you take that six, if you drop that with a modest cover, dropped down by a factor of ten, and there is already a factor of ten of overestimate. So that what we're talking about is, without any three meters, no three meters of overburden or anything of that sort, just enough to keep the wind and water from ruining things. That will drop even the highest estimates of health effects to one one-millionth of the naturally occurring lung cancer incidences in the United States. And I submit that there is no point in spending any dollars going any farther than that.

I know of no scientific basis for the proposed two pico curies of radon per square meter per second, such a standard would involve substantially more expense and more possibility of serious harm to workers and the general public due to hazards of moving large amounts of earth. And with the provisions in Public Law 95604 for federal custody of disposal sites after completion of remedial action, it would seem that a small buffer zone landscaped, but without houses around a stabilized pile, would more than suffice for radiological safety.

These could be public parks. They could be football fields, playgrounds, baseball, tennis, just don't dig holes in them. One of the problems with the Monticello tailings pile, which was stabilized years ago at A.E.C. by asking for two feet of rock and earth cover, the contractor didn't quite make it. It's about six or eight inches in some places. Some places, it's two feet thick. But the main problem they have is gophers. And the gophers go down and mine the tailings and bring them up on top. But the E.P.A. won't let them poison the gophers.

Well, I say I'm not particularly troubled by these marked uncertainties and inaccuracy concerning radon flux reduction by overburden, which we haven't discussed at all, but that's a highly techincal thing.

I'd be gald to discuss it in the most minute detail because it began in my laboratory in 1966, because we've seen that the reasons advanced for proposing two pico curies of radon per square meter per second guidelines are invalid. It's not needed, radiobiologically. It would be very expensive. It's cost, in effect, it's inflationary on the economy. And so I'm opposed.

Now, the question of longevity of standards has been brought up, and a thousand years has been spoken of, and also thousands of years has been spoken of. I served for a number of years on the National Academy of Sciences Committee on Radioactive Waste Disposal. This had to do with the high-level wastes from the reactors, and in particular, for military use. And our committee was named the committee on radioactive waste disposal.

The first thing we did was to change the name of the committee and change from disposal to management.

And it became the committee on radioactive waste management. We saw no way that it was possible to properly, to sensibly and economically take care of such things as tailings, in this case, low and high-level wastes. We thought some kind of occasional surveillance, looking at it once in a while, a month, a year, if it needs some repairs, you repair it. But to presume that any of us can predict what the country or even the continent is going to be like a thousand years from now, it seems to me to be very interesting

If you go back medically only a few hundred years, in Sam Peak's time, it was the plague, and which, as you remember, wiped out great fractions of the population quite regularly. We haven't seen any plague around for a long, long time.

Good George Washington two hundred years ago had predicted the state of commerce and population and communication, and the state of the healing arts. As of today, two hundred years later, I don't think so. The Pueblo of Los Angeles, California, was founded exactly two hundred years ago, in 1781; and the history books say with a population of twenty-six, including Mexicans, Negroes, and half-breeds, upon the site of the old Indian village Yangnog.

That's two hundred years ago, and look at what's in the Los Angeles basin now. The Aztec civilization in Central American, as you know, is tremendous, and yet it's only -- it's less than five hundred years since Cortez came in, in 1519 and destroyed it. The Norman conquest of England, 1066, and all that is less than a thousand years ago. The magna carta, which contains the roots of all --

MR. HENSLEY: Doctor Evans, I think that we -- I think that we appreciate the history lesson, and we get the point.

THE WITNESS: A thousand years is too long. One to two hundred years is enough. I'll pause at this time and be glad to respond to any questions.

MR. HENSLEY: Mr. Crout?

MR. CROUT: I'll defer any questions. I believe Doctor Evans has covered anything I would have.

MR. HENSLEY: All right, sir. Yes, sir.

CROSS EXAMINATION

BY MR. STROM:

Q May I ask you a couple of questions?

A. I'd be delighted.

Q If I could refer you to your statement about no problems, or no significant changes of the Chinese, Brazilians, and Indians who lived in the area of high alpha radiation emanation. Did you believe there was a sufficient data base employed?

A. Yes, I do. In the case of the Chinese, it's eighty thousand people for a number of centuries. In the Brazilian case, about the same. And in the case of India, it's the same. It's a religious sect which intermarries, so that they have been constant for over a thousand years.

Q. I meant from the standpoint of the problems that they had associated with living in that high background. How do you relate the statistics of no greater medical problems associated with this?

A. Oh, you look at a disease, you look at cancer incidence, for example, you look at genetics, you look at fertility, number of children per family and so forth, you look at the sex ration of males to females. This, in animal studies, is sensitive to radiation, all sorts of things of that type. Does that respond to your question?

Q. Well, I think so.

A. There must be ten or fifteen different things that are looked at.

Q. And the statistics support that?

A. Right.

MR. STROM: Thank you.

MR. HENSLEY: All right, sir.

THE WITNESS: The Chinese study was published in the science magazine not too long ago.

MR. SCARANO: It's only about three years or so.

CROSS EXAMINATION

BY MR. SCARANO:

Q My name is Ross Scarano, Doctor Evans. I enjoyed your presentation quite a bit.

A Thank you.

Q Even though I've only been in this field for about six years, I understand the complexities involved, and I appreciate your going through the long --

MR. HENSLEY: I think it would be better if you go to the microphone. People can't hear yo .

MR. SCARANO: Okay.

Q I'm confused by the beginning of your presentation as opposed to the end. And I guess I want to clarify what I think I heard. In the first portion, I had a question to ask of you, and I guess I'll ask anyway. Based on your presentation, would you advocate that no controls be placed over tailings piles?

A. Oh, no. I think I said toward the end, I'd like to see them covered in such a fashion that the wind and the rain and the weather and the freezing and the thawing and occasional flood doesn't distribute the tailings around. The tailings are just the same kind of material as an ore body in an open pit mine, and one shouldn't get scared about them. There is nothing mysterious about them at all. It's simply the uranium has been taken away from it. Everything else is there.

Q. But it's clear that -- that there should be some controls placed on them?

A. Oh, I think so. It's a dust nuisance, if nothing else, but it's not a radiological hazard in terms of the dust.

Q. Well, then that brings me, I guess, to my other question. Did you -- did I understand clearly that you said that because you cannot distinguish the radon concentration from the tailing pile at about a half a mile away --

A. That's right.

Q. -- therefore, there is no possible health effect, or no health effect?

A. From the tailings pile, right.

Q. You did conclude that?

A. That's right. The fluxations and the normal radon in any area are ten times as great as any radon that may have come from the pile.

Q. But because you couldn't tell what was coming from the pile, as opposed to the normal fluxations, the conclusion is whatever might be coming from the pile is not a health effect?

A. Then perhaps I can simplify it with some hypothetical numbers. For example, if you're in, say, Salt Lake City, and you're out ten miles from the pile, and your annual, average radon concentration is, say, point four pico curies of radon per liter, and you go in to five miles, and to two miles, and it's still the same, and you go in to one mile and it's still the same, and you go in to a half mile and it's still the same, and you go in to a quarter of a mile and you see it a little bit higher.

Q. But --

A. And that little bit higher is from the pile.

Q. But isn't it true that, you know, based on the number of samples over what period of time, you have so much fluxation just in the normal --

A. Uh-hum.

Q That you may, indeed, be receiving some contribution from the pile that because of normal fluxations you couldn't tell?

A. Oh, that's true, sure. It's buried in the statistical fluxations. It's insiginificant. It's what some lawyers call de minimus.

Q. No. I guess I don't see it that way, and I guess my question was, just because you couldn't tell that contribution from what the normal fluxations, you seem to conclude just on that basis there was no health effect from the radon, from the pile.

A. No health effects attributable to the pile, right.

MR. SCARANO: Thank you.

A. Whereby no -- I mean, no discernable, no statistically important, nothing that exceeds the normal values.

MR. SCARANO: Thank you.

A. The close-in data have been studied by the E.P.A. in some detail, as you may know, in their recent document on the inactive uranium processing sites. And there, using their modeling, they've got a maximum estimate, and it's probably high by about a factor, at least three, and probably ten of -- point eight of a cencer per year, and the population between zero and six miles from the Salt Lake City pile, the Mexican Hat pile, the Grand Junction pile, the Gunnison pile in Rifle, Colorado, in Shiprock, New Mexico. And that's in some for more than four hundred thousand persons. And the natural incidence of lung cancer in that group will be more than a hundred cases.

Q Okay.

A. That's why I say it doesn't matter, so why argue as to whether the number is point eight or point two cases per year, or point one case per year. It's negligible.

Q You did conclude that there should be some controls, some cover?

A. Yeah.

Q End controls?

A. Make a baseball field out of it.

Q Over what time frame would you say that this would be -- that this would be appropriate?

A. You mean how long would it last or when?

Q How long should these controls take place?

A. You mean when should it be done?

Q No. How long -- considering the long half-life of the tailings, and the nuisance of the dust over a long period of time, how long --

A. Well, according to the act, this land goes into federal or Agreement State ownership.

Q. So it --

A. And as was mentioned this morning, there is a fund for professional -- for perpetual care and --

Q. So it should be controlled even at those levels over a long period of time?

A. All you have to do is keep people from digging down and laying water pipes and gas lines and building houses.

Q. But you also showed us -- and we agree that you can't count on the government being around for a long time to maintain those controls, is that correct?

A. Yeah. But even so --

MR. SCARANO: Thank you.

A. -- they are not going to hurt many people.

MR. HENSLEY: I fail to see the connection between the government being around. Do you want to explain that to me?

MR. SCARANO: Yes. The conclusion was that we needed controls, make some parks out of it, some controls.

And the controls, I believe, that were alluded to were governmental controls.

MR. HENSLEY: Well, the way you make it sound is you think the government is going to collapse the day after tomorrow, and I was --

MR. SCARANO: I hope --

MR. CROUT: I'm sure sorry I paid my taxes on time.

MR. SCARANO: Mr. Chairman, I have a paycheck tomorrow. I hope it isn't going to --

MR. FONNER: Several more of my people would like to ask a few questions of Doctor Evans, if we could.

MR. STROM: May I ask some questions?

RECROSS EXAMINATION

BY MR. STROM:

Q Professor Evans, I wonder if I could refer you back to your discussion, do you believe that the conclusions that Frigerio reached are definitive?

A Yes, I do. It's good work, very sound, and has been checked by others. He's not the only person to have done it. And as I pointed out, the Horton School people are new to the field, and have come to the same conclusion, and that has just been published in a referee journal, so I believe it. No question about it.

MR. ROBINSON: Excuse me, Mr. Chairman. Before I might note I have other questions. There may be others besides the N.R.C.'s questions.

MR. HENSLEY: Allright. Hub, would you state your name for the record, please?

MR. MILLER: My name is Hubert Miller.

MR. HENSLEY: Excuse me.

CROSS EXAMINATION

BY MR. MILLER:

Q. Doctor Evans, I also appreciated your presentation. Did you say that Doctor Billy Mills was one of the coauthors of the paper that we have discussed?

A. He certainly is.

Q. And is Doctor Mills the head of the criteria and standards group at the E.P.A.?

A. He was this morning.

Q. Are you aware -- I'm glad to hear he's still got his job. And in the E.P.A. report that you just referred to a moment ago --

A. Yes.

Q. -- in fact, was prepared under his -- in his group, is that right?

A. Prepared and issued in his group, right.

Q. Are you aware that the conclusion of that report is that for the inactive uranium mill tailings piles, that radon flux should be controlled to a level of about two pico curies per meter squared per second?

A. Yes.

MR. MILLER: Thank you.

MR. HENSLEY: Just a minute.

THE WITNESS: Do you want a longer answer than that?

MR. HENSLEY: Well, no. I want to know why you referred to it as saying that the two pico curies didn't get in there, and why all of a sudden did it become important?

THE WITNESS: Well, it's in here. Doctor Mills is head of the criteria and standard division. Now, it seems that in government bureaucracies, sometimes somebody higher up on the line states what the numbers are to be, and the staff must see to it that that is what comes out in the report. I'm not citing this or any other document as being of that type, but just saying that it does occur.

MR. HENSLEY: All right.

THE WITNESS: And that Doctoor Mills

believes what is in this paper. And you'll have to ask him whether he believes any of this.

MR. HENSLEY: All right.

CROSS EXAMINATION

BY MR. BRANAGAN:

Q Edward Branagan, N.R.C. Doctor Evans, I enjoyed your presentation quite a bit, particularly the information about bone cancer. In your recent publication in <u>Nature</u>, Doctor Evans, did you use the linear nonthreshold model to estimate health effects from exposure to radon?

A. Yes. Sure.

Q Thank you.

A. Do you want to know where the linear non-threshold model came from?

A. No. I don't think we have to go into that.

A. Good. Don't you believe it, either.

Q My second question, Doctor Evans, do you agree with the mining association's contention that the risk estimators for lung cancer from exposure to radon and daughters in the G.E.I.S. is more than two orders of magnitude too high?

A. I didn't read that. What I said I believe was that you folks had used three point six times ten to minus fourth. And I think it shouldn't be any higher than one times ten to the minus fourth. Your value was for miners, not for people, anyhow, and that should drop you by a factor of three to ten. And I thought it was quite immaterial, because your regulation, your proposed regulation of two pico curies isn't based on health effects, anyhow.

Q Doctor --

A. So I don't care what number you use for risk factors, you aren't using it in deriving the regulations.

Q Doctor Evans, are you familiar with the mining association's comments on the health effects models in the G.E.I.S.?

A. Not in any detail.

Q Thank you. One other question. Earlier, you discussed some information about some of the benefits of radiation. I don't have the words exact but, Doctor Evans, in your professional opinion, is a small amount of exposure to radon and daughters beneficial?

A. Beneficial? Oh, I would say it's -- no, it's indifferent. For me, it's a zero. I believe this is personal opinion that at the low levels with which we deal, there is no effect that the -- whatever radiological effects occur on the cells in the bronchialepithelium, the basal cells, the repair mechanisms which the body has are adequate to keep up with insults at very low rates.

Q Okay. Thank you. One other point you brought up, Doctor Branagan. You referred to a study by Frigerio.

MR. HENSLEY: This is Doctor Evans.

Q Excuse me, I'm sorry, Doctor Evans -- a study by Frigerio.

A Yeah.

Q Are you aware of the B.E.I.R. III committee's review of the Frigerio study, and their comments on that?

A. No. B.E.I.R. III is wrong in a great many places, and was not peer reviewed in the proper fashion.

MR. BRANAGAN: Thank you.

MR. FONNER: Doctor Rogers has a few questions

CROSS EXAMINATION

BY MR. ROGERS:

Q My name is Vern Rogers. I have a question or two that I'd like to ask.

A. One of my students.

Q You mentioned some of the -- one of the Oak Ridge reports on ORNL-TM-5251.

A Right.

Q And this is in relation to your statement about models not giving the same distributions as observations.

A Right.

Q But overestimating grossly. Are you familiar with the modeling that was made in that report?

A Yes.

Q In the comparison there?

A Yes. And it overestimates at all distances.

Q I believe if you refer to it, it will agree when background is taken into account, as well, their other reports, most of their other reports dealing with the other major inactive piles. Are you also familiar with G.J.T.-22 radiation pathways and potential health impacts from uranium, inactive uranium mill tailings?

A No. Is that something you wrote?

Q Yes. For your information.

A Send me a copy.

Q Okay. That one also has an agreement within the experimental uncertainties there. It is true that the form of the models used in the Sixties overestimated near field radon.

A Yeah.

Q But later, the agreement is much better with a little better work with the models.

A. Is it fair for me to have a conversation here with Vern or not?

MR. HENSLEY It might be helpful to all of us.

A. Like what wind speeds and what travel time did you use for the development of working levels, down-stream from the pile?

Q. I'm talking about models on radon concentrations

A. You're only going to deal with radon, all right.

Q. Yeah. That's --

A. That's hard enough.

Q. Yes.

A. All right.

Q. I guess I was wondering about one other thing, when you mentioned that, you know, early radon flux measurements began in your lab. When was the -- that you were peripherally involved in the Shearer and Sill work in '67 and '68. When was the last time that you have made, yourself, radon flux measurement on a pile?

A. Oh, with my hands?

Q. Yes.

A. Not over -- not looking over somebody's shoulder?

Q. Yes.

A. Oh, it's been quite a while, Vern.

Q. There has been quite a development, maybe, since that time, and I just wanted to find out if you had been directly involved in these recently.

MR. ROGERS: That's all I have. Thank you.

MR. HENSLEY: Do we have somebody else?

CROSS EXAMINATION

BY MR. MARTIN:

Q. Dan E. Martin. Doctor Evans, in your paper published in Nature, did you not quote from Archer's estimate of one thousand lung cancers per million working level months?

A. Did you say did we quote it?

Q. Yes.

A. Yes, we did, but notice that the bibliographic references is not to a referee journal. You see, what Vic Archer did was to go to a symposium and give the material, and that way, you get a bibliographic reference. That's why we did the courtesy of putting it in the bibliography.

Q. Did you not in the text of that quotation say that risk estimate could not be ruled out?

A. What? Where are you?

Q. The second page of the copy that I have, the first full paragraph.

A. Oh, that speaks of any of the -- you mean the words, "Whereas it is not possible completely to rule out any of these estimates"?

Q. Yes.

A. From occupational exposure -- our objective to estimate risk, that's for occupational exposure.

Q. I realize that.

A. You see that word? Our objective is to estimate risk for the general population, and that's what this paper is about, not about miners. This is about people.

Q. But you would not rule out then a risk coefficient of one thousand lung cancers per million working level months for miners?

A. Absolutely, we did. This says it's not possible completely to rule out. That doesn't mean ninety-nine point nine percent. That means a hundred percent. You know, there is no such thing as certainty.

Q. You think that level of risk is a possibility then?

A. No, I do not.

Q. But this says --

A. No, it's based on this dose to the one-half power, the belly-up curve, it's impossible. You see, it was -- that was studied as a tremendous amount of work that is condensed into short sentences in this paper. And one of them is by Doctor C. Gordon Stewart, going over all of Archer's data, and all of the material that went into that, and doing a dose response curve with an arbitrary power function on dose, dose to the nth power, to see whether it would come out linear. So that "N" would be one, or square law, so "N" would be two, or a belly-up curve. So "N" would be one-half.

And the answer to all this, as I recall it was optimum slope. The most probable slope is point nine seven plus or minus point one five, or something like that, which was linear, and which definitely says that the Archer hypothesis is invalid. And that's where that thousand comes from, that original one. If you go to a low enough value, on a curve of this sort, it has an infinite slope, but the origin -- and that means that for the first tenth of a working level month, you've got infinite risk, all right?

If risk is dose to the one-half power, and you ask the first differential of risk with respect to dose, you get one over dose to the one-half power, don't you?

Q I think I would like to ask another question.

A. Have you ever taken differential calculus?

Q I'm not testifying.

MR. HENSLEY: He has another question, Doctor Evans.

THE WITNESS: Go ahead.

Q Your estimate in this paper of one times ten to the minus four cancers per working level months for the general population, was that based on a conversion factor of fifty working level months per working level?

A. Fifty.

Q Fifty working level months per year per working level?

A. Oh, you're talking now about the conversion between working level year, twenty-four hour, hundred percent occupancy basis?

Q Yes.

A. Yes, this is working level months, honest to goodness working level months. And any working level month that has a breathing rate put into it should be cancelled and thrown out immediately, because it is not part of the definition of the unit. And the answer is yes, one working level year of eight thousand seven hundred sixty hours is fifty-one working level months.

Q. Are you aware that we used a different conversion factor in the G.E.I.S.?

A. I'm sorry to say I'm aware you did that, and I hope you quit it.

Q. Do you understand that if we had used the fifty working level months per working level coefficient that you used, we would have gotten a risk factor one-half of what we arrived at?

A. You're getting close.

Q. And that would be a factor of two closer to what you --

A. Getting better all the time.

Q. -- than what you have calculated here?

A. Right.

Q. You agree to that?

A. Sure, but it doesn't matter since you didn't, because your rules on health effects --

MR. HENSLEY: All right. Mr. Fonner do you have someone else?

MR. FONNER: I don't think so, no, sir. We are finished.

MR. HENSLEY: Mr. Robinson, I believe you asked permission to speak.

MR. ROBINSON: Thank you, Mr. Chairman. There is, of course, on the order of --

MR. HENSLEY: State your name.

MR. ROBINSON: Paul Robinson, Southwest Information and Research Center. I believe there is about five minutes left with this witness, is that our time frame, sir?

MR. HENSLEY: I think that's his time frame.

CROSS EXAMINATION

BY MR. ROBINSON:

Q. When you mentioned the uranium environmental study with the University of New Mexico --

A. Yes.

Q. -- you stated some results from this study.

A. Well, only in very broad terms, because it's an ongoing study, and so everything is preliminary for a long time.

Q. I believe you --

A. But the preliminary results of the status is certainly very, very encouraging, and says radon in the mines is now absolutely safe.

Q So you would say that radon in mines is now absolutely safe?

A. At four working level months per year, yes.

Q And that is a preliminary statement, you feel?

A. I feel that four working level months per year in the mines is safe.

Q Based on this study?

A. No. No. No. Based on all the work we did in the Federal Radiation Council beginning in 1962, culminating in the Federal Radiation Council reports in 1967, the joint committee on atomic energy hearings in 1967 on radon hazards in miners, and the final reports of the Federal Radiation Council backed by what you're saying now, and with monitoring of all of the subsequent lung cancers, and of the lung cancer types which have been seen by Gino Sakomono and his colleagues at Saint Mary's Hospital in Grand Junction.

Q With all due respect, Doctor, I enjoyed your testimony, as well, and appreciate your style, but we are trying to get through a list of questions, and you do have a time constraint. I'm trying to ask a line of questions and would appreciate if the Chair would help me stay on that line.

MR. HENSLEY: We'll try, Mr. Robinson.

Q. This epidemiologic study has no results published, has it?

A. No.

Q. We are less than one latent period into the lifetime of the miners subject to that study, is that correct?

A. I wouldn't say less than. I'd say about.

Q. About. So you're saying that a study which initiates with miners in 1971, and is now in 1981, is about the latent period of radon induced lung cancers?

A. The study goes back to '61, and before.

Q. The -- you're saying that that study does not eliminate miners which work in more than four working level month mines?

A. Correct.

Q. Thank you.

A. See, there is a new director, and the rules are changed.

Q. Yes, I know Doctor Sanders, as well. When you discussed the B.E.I.R. III report, you said that there were errors in fact?

A. Right.

Q. I'm wondering if there are other people who might state that as there is controversy over that report, and that they might feel that you had errors in fact?

A. I didn't have any input into it.

Q. But in terms of the scientific discussion, I'm not stating that you have errors. I have a great deal of respect for your work. I'm wondering if -- whether your statement was -- would be more properly put that there is significant controversy over that report, rather than there are errors in fact?

A. There are errors of fact.

Q. Of fact? Now, the chairman of this B.E.I.R. committee is Doctor Radford of the University of Pittsburgh, is that correct?

A. I think that's where he is now, yes.

Q. Thank you. And this is one -- this Doctor Radford is one of the coauthors of the paper by Doctor Archer which you consented to use in your Nature paper?

A. What about Nature?

Q. That you used in your Nature paper.

A. No. No. Ted's name is not on that. That's one of Vic Archer's. I believe the reference we used was one of Vic Archer's most recent symposia attendances. Have you looked it up? He's the sole author, reference fourteen. V. E. Archer, Transactions of the American Nuclear Society.

Q Thank you. Doctor Radford is the coauthor of the Axelson report which you were critiquing earlier?

A Yes.

Q When you stated your recommendation for stabilization as keeping wind and water from ruining things, I'm wondering what levels of cover or other materials you would recommend to keep wind and water from ruining things?

A Well, that's not my field, but I would suggest that something on the order of one to two feet thick is adequate.

Q How long do you think the one to two foot thick material would protect from wind and water erosion?

A That's not my field.

Q Would you say that was a relevant question for this forum, whether it's your field or not?

A I think one to two feet would last for quite a while, based on what has happened with the Monticello pile.

Q Quite a while? How long would you say that quite a while would be?

A A significant fraction of one to two hundred years.

Q Is that significant at all with respect to the lifetime of hazard from tailings piles?

A Oh, the -- well, you and I know what half-period of ionium is. It's long, of course, twenty thousand years.

Q A fraction of a hundred to two hundred years?

A It's constant.

Q Is a small fraction then of that lifetime of hazard?

A The lifetime of the radium and radon in the tailings piles should be taken for human beings such as us, and for the next two hundred years as being infinite, just being constant, it's a constant level.

Q Thank you.

A And a lifetime is more than fives times the time span since the last Ice Age. And I don't know what the continent is going to be like then.

Q Thank you. When you were introducing your comments, you stated that the hazard was not with radon, but with its daughters?

A Yes.

Q I'm wondering if it might be more properly said that the hazard is with the decays between radon and its daughters, that the alpha particle and the energy release is where the hazard occurs with respect to the lung problems, rather than with the solid materials. Would you agree with that?

A. If I understood your question, I do not agree with it. The hazard is from the solid decay products beginning with radium A, which has a plutonium isotope of a half-life of three minutes.

Q. So you're saying that it's the plutonium that causes the change in the bronchial epithelium rather than the decay into plutonium that releases energy and a particle into those cells?

A. Certainly, the lung is a filler which takes out the solid decay products that are floating around in the air. It's just a filler.

Q. Thank you. Which of the inactive piles did you feel were stabilized?

A. One more question. Which of the inactive --

Q. -- tailing piles did you feel were stabilized?

A. Those that are listed in E.P.A. documents, and Monticello in particular.

Q. You're saying that E.P.A. represents those piles as fully stabilized?

A. The word is not "fully." The word is "stabilized

Q. Could I --

A. You go ahead while I'm packing.

Q. I understand the doctor has to leave. I've read the same document, and the next sentence says that, "No piles are adequately stabilized. Some have been attempted"

A. They are adequately now, and are judgmental matters.

Q. I'm wondering whether stabilized is something which degrades and is maintained over time, or whether it's an instantaneous reading, and I think that's significant.

A. Grand Junction is stabilized, too. It was all regraded and reworked in 1970.

Q. And that stabilization is still considered fully intact?

A. Well, I suppose that would depend on who you asked. I think the local people regard it as fine.

MR. ROBINSON: Thank you. Well, I have about ten other questions which I will just make mention of that and leave the doctor. It's hard to concentrate. I just want to leave by saying, I hope with respect to the doctor -- I have a great deal of respect for his work, and pardon being blunt --

MS. TAYLOR: Well there be an opportunity for people in the audience to cross examination Dcotor Evans. I have at least ten different questions which would take about five to ten minutes, and I think that every one in the audience that wants to cross examine should have an opportunity to do so. I also have one or two questions.

MR. CROUT: Would it be possible for written questions to be submitted to Doctor Evans, and the board transmit it to him, and he transmits the answer back to the authors, and they decide whether they wish to file it with the board or not?

MR. HENSLEY: I think the only way, ma'am -- we knew about this constraint when we started. If you will write your questions, we will get them transmitted to Doctor Evans, and that we will have them back, and we will make those answers to those questions a part of the record.

MS. TAYLOR: Thank you.

THE WITNESS: Mr. Chairman, there is a time constraint on me in terms of answering. I'll be out of town for the next two or three weeks.

MR. HENSLEY: No, it will be prior to the closing of the documents.

THE WITNESS: I'll do my best.

MS. TAYLOR: Does that mean that the comment period will be extended to incorporate this cross examination?

MR. HENSLEY: Yes, ma'am.

MS. TAYLOR: What is the --

MR. HENSLEY: I'm saying the closing of the record. In other words, he's going to be out of town for two or three weeks. When he gets back, he will answer those questions, and then at that time, they will be incorporated into the record.

MS. TAYLOR: So that means that the comment period is essentially being extended for thirty days after these hearings?

MR. HENSLEY: Yes, ma'am. Well, it will probably be for longer than that.

MS. TAYLOR: I just wanted to make sure that they would have enough time to get in before time was cut off.

MR. HENSLEY: I assure you of that, that it would be extended.

MR. ELLISTON: Elizabeth Elliston from Sandoval County. And I would like to regret that though we have put some of the people who are going to go last, first, the testimony that the people have been hanging around for a long time, waiting to participate in this, and have questions to ask, are unable to do so at this time.

MR. HENSLEY: Yes, ma'am, but I think that you'll find that this is the only one that you've got that problem with. And if you will put your questions in writing, they will be answered.

MS. ELLISTON: I understand that, and I appreciate that, but I would like to be able to talk to Doctor Evans, and look him in the eye, and hear his answers. And I respect his ability as a teacher, and I've learned a lot from this session. Thank you very much.

THE WITNESS: I surely wish I could stay and talk with you.

MS. TAYLOR: For purposes of the record, my name is Linda Taylor, and I'm with New Mexico Physicians for Social Responsibility.

MR. HENSLEY: Thank you, ma'am. Mr. Fonner, you may continue with your presentation, sir.

MR. FONNER: I have one document that we'd like to put into the record. It's a letter from Doctor Evans to Doctor Mills of E.P.A., pertaining to some of the questions that the N.R.C. witnesses were asking Doctor Evans. And could we put that into the record at this point, or do you want the witness to identify it first?

MR. HENSLEY: Yes, I would like you to identify that document, Doctor Evans.

MR. MONTANGE: While N.R.C. is looking at that, this is the paper by Shearer and Sill that Doctor Evans referred to as the evaluation of atmospheric radon in the vicinity of uranium mill tailings, and I'd like to submit that as an exhibit for Kerr-McGee.

MR. CROUT: The uranium environmental sub-committee wants to introduce the article that's on your --

MR. FONNER: Excuse me, Mr. Chairman. We think the letter is not relevant to the subject matter of this proceeding. It deals an E.P.A. -- 40 C.F.R. 192.

MR. CROUT: This is the one they referred to.

MR. MILLER: It's not the same standard at all.

MR. MONTANGE: Very, very much is. Doctor Evans, does this refer to the standard that you -- was in this red book that was discussed with the N.R.C. witnesses? Is this the same standard --

THE WITNESS: Well, this refers --

MR. MONTANGE: -- that N.R.C. wants New Mexico to adopt here?

THE WITNESS: Yes, for inactive --

MR. MONTANGE: Two pico curies per second?

THE WITNESS: For instance, to the Phillip's pile, yes. Inactive tailings piles, right.

MR. MONTANGE: The two pico curies per meter squared per second? I move this as Kerr-McGee Exhibit --

MR. HENSLEY: Do you wish to enter an objection for the record?

MR. FONNER: Yes, for the record, I'd like to object to it. It's not relevant to the regulations proposed.

MR. HENSLEY: It will be entered, marked.

I have here atmosphere of mill tailings, a document which they've entered to be placed into evidence. Do you have any objection to that?

MR. DAVIS: My name is Ted Davis, and I'm a physician here in Albuquerque. I also would like to object to the inability of myself to cross examine in person, Doctor Evans. I think that's unfortunate, and I wish I had an opportunity. I will try and submit questions but it would certainly be more appropriate to have a dialogue while he's here.

MR. MONTANGE: Mr. Chairman, I'd like to note that one of the reasons that we don't have time for full cross examination of any of the witnesses is that N.R.C. is pushing so hard to get the state to adopt these regulations by a time certain, that there simply isn't time to have sufficient proceedings to conduct all the cross examination of any of the witnesses which any of the parties, including ourselves, would like.

MR. HENSLEY: Is Doctor Evans a local resident?

MR. STROM: He's from Arizona.

MR. HENSLEY: He's from Scottsdale. I was going to say that he said he was going to be out of town for two or three weeks. I would like, and I share -- that's like I said, I had enough up here to last forty-five minutes by myself, but I did not get mine in, either. I would like some time -- as I said, I was leaving the record open. If we could get Doctor Evans back for you people who weren't allowed to cross, I would love to get him back, too, but that's one we'll have to cross. And if you'll leave your name and address and all of this, we'll see if we could get that done.

MR. ROBINSON: Mr. Chairman, in response

to Mr. Montange's last statement, I believe that one will find that the lenthiest part of this hearing so far has been the operator's testimony of witnesses, and that it is the state which has proposed the rules for hearings, not the N.R.C.

MR. HENSLEY: It has been their cross of witnesses that has been put on. It has not been their testimony. It has been their cross.

MR. ROBINSON: I thought I said "questioning," but I just wanted to make that brief statement.

MR. HENSLEY: Yes, sir.

MR. FONNER: We have no objection to this document. We would just like to object for the record that this S. D. Shearer and Sill study is already pretty old, but we have no objection to it.

MR. HENSLEY: So noted.

(THEREUPON, Kerr-McGee Exhibits One and Two were marked for identification.)

MR. HENSLEY: This one is what?

MR. CROUT: Uranium Environmental Subcommittee Exhibit B.

(THEREUPON, Uranium Environmental Subcommittee Exhibit B was marked for identification.)

MS. TAYLOR: I'm sorry to keep harping on the lack of cross examination of Doctor Evans, Mr. Chairman, but I'd like to make one more request. Would it be possible to have our questions answered by Doctor Evans in the context of where he finished his presentation, so that they are not stuck in the back of the hearing transcript, because much of the questions that I had contradicted substantially the statements that were made by him today. And if they are stuck in the back, I don't think people reading the hearing transcript would have the benefit, particularly the general public.

MR. HENSLEY: I think that we can mark -- we will mark within that it would have to go into the exhibits, and there will be a -- we can place into the record at this point that the exhibits should be examined for continuation of written answers to questions submitted by people within the audience.

MS. TAYLOR: Thank you very much.

MR. FONNER: Could we ask --

(THEREUPON, a recess was held.)

REPORTER'S CERTIFICATE

I, KATHY TOWNSEND, a Court Reporter for the firm of HOWARD W. HENRY & COMPANY, do hereby certify that I reported the foregoing case in Stenographic Shorthand and transcribed, or had the same transcribed under my supervision and direction; and that the same is a true and correct record of the proceedings had at that time and place.

I further certify that I am not employed by any of the parties to this action or attorneys appearing herein, and that I have no financial interest in the outcome of this case.

WITNESS my hand this 28th day of June, 1981, at my offices in Albuquerque, New Mexico.

Kathy Townsend
Court Reporter

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EXHIBITS

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The Colorado

MINING ASSOCIATION

DAVID R. COLE
Secretary and Manager

June 5, 1981

Radiation and Hazardous Wastes Control Division
Colorado Department of Health
4210 E. 11th Avenue
Denver, Colorado 80220

Attention: Frank A. Traylor, M.D.
Executive Secretary, Colorado Board of Health

Re: Comments on Proposed Revisions to Colorado Radiation Control Regulations and Related Documents

The attached comments are submitted on behalf of the Colorado Mining Association and the members of that Association which are or which contemplate engaging in uranium milling in the state of Colorado. These comments address the proposed revisions to the Colorado Radiation Control Regulations which are before the Board for action at the hearing scheduled for June 17, 1981.

The present revisions have been proposed by the Radiation and Hazardous Wastes Control Division of the Department of Health and were previously submitted to the Board. The proposals have been made available to the Colorado Mining Association and the members of that Association engaged in or contemplating uranium milling. The proposals have been carefully analyzed, and the comments represent the combined effort and careful consideration by technical, administrative and legal representatives of all the concerned companies.

We are very aware of the mandate placed upon the Department of Health by the provisions of Public Law 95-604 and the guidance and directives furnished to agreement states by NRC in connection with that statute. We are also aware of the intensive work done by the Division of Radiation and Hazardous Wastes Control in preparing these proposals under the strictures of the federal action. We are appreciative of the efforts

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made by the Division to reconcile the state program with the federal requirements. It should be noted, however, that many of the substantive provisions included in the proposed revisions are currently being challenged by CMA members in the federal courts (see, e.g. Kerr-McGee Nuclear, et al. v. N.R.C., C.A. No. 80-2043, USCA-10). Although CMA members favor continuation of Colorado's agreement state status, we cannot take a position with respect to the state regulations which is inconsistent with our position regarding similar NRC requirements. Accordingly, we intend to pursue all available administrative and judicial remedies in challenging regulations which we believe to be illegal or inappropriate.

Our comments will follow the following format:

I. Comments on the proposed rationale for the regulations.

II. Comments on the proposed fiscal impact statement.

III. Comments on the proposed revisions to the regulations.

IV. Comments on proposed Part III, Schedule E, of the regulations.

Thank you for the opportunity to present our comments.

Sincerely,

David R. Cole

DRC/z

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I. COMMENTS ON PROPOSED RATIONALE.

The draft rationale inaccurately reflects the standard for agreement state conformity with the program of the United States Nuclear Regulatory Commission subsequent to the enactment of the Uranium Mill Tailings Radiation Control Act of 1978 (Public Law 95-604).

Prior to the enactment of Public Law 95-604, the Atomic Energy Act of 1954 required that the programs of agreement states be "compatible" with that of NRC, in order that agreement state status be maintained. Public Law 95-604 is a statute which is aimed directly and specifically at management, control and disposition of uranium mill tailings. In the amendment, the standard for agreement state conformity with the NRC program is stated in terms of "equivalency". The equivalency test, however, is applicable only to "byproduct material" which is redefined by Public Law 95-604 to include uranium mill tailings. For aspects of agreement state programs other than those relating to byproduct material as redefined, the standard for conformity remains that contained in the Atomic Energy Act of 1954, to-wit: compatibility.

II. COMMENTS ON PROPOSED FISCAL IMPACT STATEMENT.

The Colorado Administrative Procedure Act, §24-4-101, et seq. C.R.S. (1973) obligates state agencies to evaluate the economic impacts of their rule-making activities. See, e.g §24-4-101.5, C.R.S. (1973). Pursuant to this requirement, all rules proposed by the Department and adopted by the Board must be accompanied by a fiscal impact statement identifying the persons or groups who will bear the cost of the rule.

Pursuant to the foregoing requirements of the APA, the Division has appended a fiscal impact statement to the proposed regulations. Simply stated, the Division is taking the position that the proposed regulatory changes will have virtually no fiscal impact, with the exception of certain license fee increases.

Contrary to the Division's estimates, the cost increases to licensees resulting from the revised regulations will be dramatic, to say the least. Licensees will be forced to bear increased costs in the following areas:

1. License fees

2. Sureties

3. Reclamation, Decommissioning & Long-term Care

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4. Administrative & Legal

5. Consulting fees

In the case of operations currently conducted by two licensees operating mills in Colorado (Union Carbide Corporation and Cotter Corporation), the revised regulations will result in cost increases in excess of $50 Million. Such cost increases will occur in the following areas:

	Present Regulations	New Regulations	Difference
1. LICENSE FEES	$295,500	$452,500	+$160,500
2. SURETIES	$230,000	$2,115,000	+$1,885,000
3. RECLAMATION, DECOMMISSIONING & LONG TERM CARE	$5,875,000	$56,850,000	+$50,975,000
4. ADMINISTRATIVE/ LEGAL	$312,250	$1,043,000	+$730,750
5. CONSULTING FEES (cover design & placement, ground water monitoring, air emission controls, and preparation of expanded ER)	$950,000	$2,450,000	+$1,700,000
TOTAL:	$7,462,750	$62,910,000	+$55,447,250

III. COMMENTS ON PROPOSED REVISIONS TO THE REGULATIONS.

Our comments on the proposed revisions to the regulations are in the following format:

A. Recitation of the particular rule or portion thereof being addressed;

B. CMA's proposed revisions to the rule, or, where appropriate, proposed additions where no rule has previously existed; and

C. Comments on the proposed revisions or additions.

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RH 3.9.4.1

An applicant may be required to furnish financial surety arrangements to insure the protection of the public health and safety in the event of abandonment, default, or inability of the licensee to meet the requirements of the Act, these regulations, and the license including decontamination, and decommissioning of the facility.

PROPOSED REVISIONS:

An applicant may be required to furnish financial surety arrangements to insure the protection of the public health and safety in the event of abandonment, default, or inability of the licensee to comply with decontamination, decommissioning, and reclamation requirements imposed as a condition of licensure.

COMMENT:

As presently worded, proposed RH §3.9.4.1 would allow CDH to draw against a licensee's financial surety arrangement (bond, letter of credit, or certificate of deposit) based on any alleged violation of the license, or of the Radiation Control Act and CDH regulations. RH 3.9.4.1 will thus function as a prepaid civil penalty provision, enabling CDH to draw against the surety whenever it determines that a license violation has occurred. Proposed RH §3.9.4.1 goes far beyond the enforcement powers delegated to CDH by the Colorado Radiation Control Act, which does not give CDH the power to impose civil penalties for license violations. It is a well established rule in Colorado that a regulation issued by an administrative body, in order to be valid, must be within the scope of the statutory delegation of authority which underlies the regulation. See, e.g., Dixon v. Zick, 179 Colo. 278, 500 P.2d 130 (1972). Proposed RH §3.9.4.1 is clearly inconsistent with its underlying statutory authority, and thus is unlawful. It should be noted that an attempt to amend the Radiation Control Act to grant CDH the power to impose civil penalties (H.B. 1263) was defeated in the General Assembly during the present session. The Department cannot gain powers by rulemaking which the General Assembly has refused to delegate by statute.

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RH § 3.9.4.2

The financial surety arrangement required by 3.9.4.1 shall be furnished to and in a form approved by the Department prior to the issuance of a license, or any amendment or renewal of an existing license, as required by the Department. The applicant shall furnish such evidence of initial and continued financial surety responsibility sufficient to maintain the financial surety in force, as required by the Department. The amount of funds to be insured by such surety arrangements shall be based on Department approved cost estimates. Self-insurance, or any arrangement which essentially constitutes self-insurance will not satisfy the surety requirement.

PROPOSED REVISIONS:

Change the last sentence to read as follows: Self-insurance, or any arrangement which essentially constitutes self-insurance, will not satisfy the surety requirement, provided, that self-insurance shall be authorized for the long-term care requirements of §3.9.5, and provided further, that certain types of self-insurance, such as collateral bonding may be acceptable, where the licensee's assets are of sufficient size to warrant this type of surety.

COMMENT:

Self-insurance may be appropriate particularly for long-term care requirements. During the period of active operations, long-term care requirements are not necessary. This is recognized by the NRC rules and guidelines as well as the final GEIS. Although this section purportedly applies only to the "performance surety" requirements, clarification should be added to allow self-insurance for long-term care requirements during operations and before decommissioning. Self-insurance is also a viable means of providing surety in cases where the licensee is a major corporate entity with extensive financial assets. There is no reason to prevent large corporate licensees from using their own assets as collateral to secure performance of reclamation or long-term care requirements.

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RH 3.9.4.2.5

Such other evidence of initial and continued financial responsibility as may be required by the Department, including financial surety previously provided to any state or federal agency concerning activity subject to license under these regulations, or the amount, terms and conditions of such surety have been established to the satisfaction of the Department, provided such arrangements are considered adequate to satisfy these requirements and that portion of the surety which covers the decommissioning and reclamation of the facility and associated areas, and the long-term monitoring and maintenance are clearly identified.

PROPOSED REVISION:

Add a new RH 3.9.4.2.5 which would read as follows: A contractual lien on all buildings and structures on the affected lands. Such lien shall be accompanied by information on the estimated costs of removal of the buildings and structures, and information on the salvage value of the materials and components.

Re-number existing RH 3.9.4.2.5 to RH 3.9.4.2.6.

COMMENT:

This revision will add another element of flexibility for providing acceptable surety which will be less costly to the operator while ensuring the availability of funds to the state.

RH § 3.9.4.5

The licensee's surety mechanism will be reviewed annually by the Department and be adjusted to recognize any increases or decreases resulting from inflation, changes in engineering plans, activities performed, and any other conditions affecting costs. An appropriate portion of surety liability shall be retained until final compliance with the reclamation plan is determined.

PROPOSED REVISION:

The licensee's surety mechanism will be reviewed annually by the Department and be adjusted to recognize any increases or decreases resulting

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from inflation, changes in engineering plans, reclamation and other activities performed, and any other conditions affecting costs. An appropriate portion of surety liability shall be retained until final compliance with the reclamation plan is determined.

COMMENT:

The addition of "reclamation and other" activities specifies one added major item affecting surety costs.

RH § 3.9.5.4.1

The final disposition of tailings or wastes should be such that the need for ongoing active maintenance, as defined in the final generic environmental impact statement on uranium milling, is not necessary to preserve isolation. As a minimum, annual site inspections shall be conducted by the government agency retaining ultimate custody of the site where tailings, or wastes are stored to confirm the integrity of the stabilized tailings, or waste systems and to determine the need, if any, for maintenance and/or monitoring. Results of the inspection shall be reported to the U.S. Nuclear Regulatory Commission within 60 days following each inspection. The U.S. Nuclear Regulatory Commission may require more frequent site inspections if, on the basis of a site-specific evaluation, such a need appears necessary due to the features of a particular tailings or waste disposal system.

PROVIDED REVISION:

The final disposition of tailings or wastes should be such that the need for ongoing active maintenance is, to the maximum extent practicable, eliminated. As a minimum, annual site inspections shall be conducted by the government agency retaining ultimate custody of the site where tailings, or wastes are stored to confirm the integrity of the stabilized tailings, or waste systems and to determine the need, if any, for maintenance and/or monitoring. Results of the inspection shall be reported to the U.S. Nuclear Regulatory Commission within 60 days following each inspection.

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COMMENT:

This amendment is proposed in order that the responsibility of the regulator and the obligation of the licensee comport with reality. Just as there is no such thing as "zero discharge" from an impoundment, there is no method of disposal which absolutely assures that no need for maintenance might occur hundreds of years in the future. To create a requirement contrary to that reality may well give rise to false expectations and to findings required by the license issuer which cannot in honesty be made, and which, if made, produce protracted litigation seeking to overturn the licensing action.

The language proposed for deletion is a statement of the regulatory program of USNRC. It has no applicability to the operations or requirements of the State of Colorado, and no relevance to the performance of a licensee in an agreement state. The statement is enlightening but irrelevant to a regulation dealing with the licensing and operation of uranium mills in Colorado.

RH § 3.9.5.4.2

A fund shall be established based on Department approved cost estimates, and for source material milling operations shall not be less than $250,000 (1978 dollars). The funds provided by the licensee shall yield interest in an amount sufficient to cover the average annual cost of monitoring and maintenance of the site based on an assumed 1% annual real interest rate. An annual review of the inflation rate and interest yield will be accomplished by the Department and necessary changes made in the long-term care agreement with the licensee. The inflation rate to be used is that indicated by the change in the Consumer Price Index published by the U.S. Department of Labor, Bureau of Labor Statistics.

PROPOSED REVISIONS:

A fund shall be established based on Department approved cost estimates, after consultation with the licensee. The fund shall not in any event be less than $250,000. The funds provided by the licensee shall yield interest in an amount sufficient to cover the average annual cost of monitoring and maintenance of the site

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based on an assumed 2% annual real interest rate. An annual review of the inflation rate and interest yield will be accomplished by the Department and necessary changes made in consultation with the licensee in the long-term care agreement with the licensee.

COMMENT:

This provision has been changed to prevent automatic and unilateral amendment of the license by the state. Reference to an automatic index for inflation adjustment eliminates requisite flexibility for the operator as well as the state. In any given year, the Consumer Price Index (CPI) may bear little or no relation to the actual inflation rates prevalent in the mining and milling industries. These adjustments must be allowed to remain the subject of yearly negotiations between operators and the state. An automatic adjuster, particularly the CPI, is totally arbitrary and inflexible. Commentors further request that a 2% annual real interest rate be used rather than the proposed 1% rate. The basis for this request is that a 2% annual real interest rate is a more accurate reflection of the historic earning power of investments. Research performed by Union Carbide Corporation's corporate finance group has shown that the average domestic corporate bond yield over the last 30-year period (1950-1980) exceeds the GNP deflator by 2%. Supporting data on the research performed by Union Carbide Corporation's corporate finance group will be supplied as an appendix to these comments at the hearing on June 17, 1981.

RH § 3.9.9.2.1.3

The matters of fact and law asserted or to be considered.

PROPOSED REVISION:

The matters of fact and law asserted or to be considered, to the extent then known.

COMMENT:

This amendment is proposed in order to eliminate the interposition of highly technical appeals based upon assertions of inadequate notice. License notice and hearing process established in the regulation contemplates and even encourages

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the formulation and refinement of issues even after notice has issued. This process could easily be thwarted and perverted if the notice provision is lacking in flexibility. One of the most common grounds of administrative appeal is based upon claims of inadequate notice resulting in deprivation of due process.

RH § 3.9.9.3.2

Application for party status must identify the individual or group applying, state an address or phone number where they may be contacted, state the nature of their interest in the hearing, and the specific ground on which they claim to be affected or aggrieved, and state the specific aspects of the hearing to which they wish to address.

PROPOSED REVISION:

Application for party status must identify the individual or group applying, and its address and telephone number. The application shall be signed by the party or his authorized representative, or by an attorney having authority with respect to it. The capacity of the person signing, his address, and the date shall be stated. The signature of a person signing in a representative capacity is a representation that the document has been subscribed in the capacity specified with full authority, that he has read it and knows the comments, that to the best of his knowledge, information, and belief the statements made in it are true, and that it is not interposed for delay. If a document is not signed, or is signed with intent to defeat the purpose of this section, it may be stricken. The application document must include the following elements:

1. The nature and extent of the applicant's property, financial, or other interest in the proceeding, and the specific ground on which the applicant claims to be affected or aggrieved;

2. The possible effect of any order which may be entered in the proceeding on the applicant's interest;

3. The specific aspects of the hearing which the applicant intends to address. If the applicant objects to certain conditions in a proposed license, the proposed alternative

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condition(s) must be included in the application;

4. The general nature of the testimony and/or evidence which the applicant intends to present at the hearing.

COMMENT:

See comments on RH § 3.9.9.3.3 *infra*.

RH § 3.9.9.3.3

The Department, or the hearing officer, will grant or deny party status based on the nature and extent of the person's property, financial or other interest in the hearing and the possible effect of any order which may be entered as a result of the hearing on the person's interest. Any person applying for a granted party status may, by motion to the hearing officer or Department, as appropriate, challenge the right of any other person to be a party.

PROPOSED REVISION:

The Department, or the hearing officer, will grant or deny party status based on consideration of the following factors:

1. The nature and extent of the applicant's property, financial, or other interest in the hearing;

2. The possible effect of any order which may be entered in the proceeding on the applicant's interest;

3. The extent to which the applicant's interest will be represented by existing parties;

4. The extent to which the applicant's participation may reasonably be expected to assist in developing a sound record;

5. The availability of other means whereby the applicant's interest will be protected; and

6. The extent to which the applicant's participation will broaden the issues or delay the proceedings.

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COMMENT:

The proposed changes in §§ 3.9.9.3.2 and 3.9.9.3.3 concerning elements of the application for party status, and the criteria for granting party status, are taken from the NRC's procedural rules (10 C.F.R. 2.708-2.714), and the Rules of Procedure Before the Colorado Water Quality Control Commission, both of which govern requests for party status and intervention in administrative hearings. While commentors have no objection to the provisions of the proposed rule, we believe that the procedural and substantive criteria for party status should be more fully developed to insure against frivolous applications by persons who generally are opposed to nuclear power as a fuel source and would seek to appeal or intervene in licensing proceedings on that basis.

RH § 3.9.9.3.4

Parties and persons who have applied to become parties shall have the right to initiate discovery. Parties shall have the right to make motions or objections, present evidence, cross-examine witnesses, and appeal from the decision of the hearing as provided by the Colorado Administrative Procedure Act, 24-4-101 et seq. C.R.S. 1973 as amended.

PROPOSED REVISION:

Parties shall have the right to initiate discovery. Parties shall have the right to make motions or objections, present evidence, cross-examine witnesses, and appeal from the decision of the hearing as provided by the Colorado Administrative Procedure Act, 24-4-101 et seq. C.R.S. 1973 as amended.

COMMENT:

The provision that persons who are not and may never become parties may exercise the right of discovery, one of the most significant rights of a party, is an invitation to misrule and abuse. The Department defends the proposal on the grounds that the rights of those who may become parties to participate fully must be preserved. This concern can be addressed adequately by amendments to the party provisions (3.9.9.3.1) shortening the 20-day period for application for party status, and prescribing

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action upon such application by the hearing officer within a short period, perhaps five days, thereafter (3.9.9.3.3).

RH § 3.9.9.4.2.1

A brief summary of the nature of the claim of the party and the basis therefor:

PROPOSED REVISIONS:

A brief summary of the contentions and evidence to be offered in the case in chief of the party and the basis therefor:

COMMENT:

These are editorial comments which are self-explanatory.

RH § 3.9.9.5.1

Any party or person who has applied to become a party may initiate discovery in the form of interrogatories to another party, requests for admission to another party, requests for production of documents to another party, or depositions of any persons: or any combination thereof. The Colorado Rules of Civil Procedure, to the extent not inconsistent with the State Administrative Procedure Act shall apply. Such discovery may be modified by a motion for protective order filed with the department or hearing officer within seven (7) days of receipt of the notice of request for discovery. Motions for protective order shall set forth the grounds in support thereof and shall be ruled upon immediately. Discovery shall be completed no later than ten (10) days preceding the hearing date, except as otherwise ordered by the department or hearing officer.

PROPOSED REVISION:

Any party may initiate discovery in the form of interrogatories to another party, requests for admission to another party, requests for production of documents to another party, or depositions of any persons: or any combination thereof. The Colorado Rules of Civil Procedure, to the extent not inconsistent with the State Administrative Procedure Act shall apply. Such discovery may be modified by a motion for protective order filed with the department or hearing

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officer within seven (7) days of receipt of the notice of request for discovery. Motions for protective order shall set forth the grounds in support thereof and shall be ruled upon immediately. Discovery shall be completed no later than ten (10) days preceding the hearing date, except as otherwise ordered by the department or hearing officer.

COMMENT:

The comment to this proposed change is the same as that made in connection with section 3.9.9.3.4.

RH § 3.9.10.1.3

Consideration of alternatives to the activities to be conducted, including alternative sites and engineering methods;

PROPOSED REVISION:

Consideration of alternatives to the activities to be conducted including alternative sites and engineering methods, but excluding consideration of generic as opposed to project specific issues relating to energy choices, economics and the like;

COMMENT:

The purpose of the suggested limitation is to avoid involving the Department in generic considerations which represent societal, political or economic judgments beyond the statutory duty and expertise of the Department.

RH § 3.10.6.1.6

Site and project alternatives.

PROPOSED REVISION:

Site and Project alternatives excluding, however, alternative modes of energy production or other alternative considerations involving societal, political or generic economic judgments.

COMMENT:

The comment made in connection with the modification proposed to 3.9.10.1.3 is applicable here.

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RH § 3.‑‑

Amendment of licenses at request of licensee. Applications for amendment of a license shall be filed in accordance with RH § 3.8 and shall specify the respects in which the licensee desires his license to be amended and the grounds for such amendment. (No revisions proposed by CDH).

PROPOSED REVISIONS:

Amendment of licenses at request of licensee. Applications for amendment of a license shall be filed in accordance with RH § 3.8 and shall specify the respects in which the licensee desires his license to be amended and the grounds for such amendment. For purposes of this section, the term "license amendment" shall be defined as a process change which results or has the potential to result in a net increase in routine operational releases of radioactive particulates and/or radon gas from the licensed facility.

COMMENT:

No change in this regulation has been included in the proposed revisions. Commentors believe that the present RH 3.17 is deficient, and the proposed revisions should include a change in this section. This section is deficient in that it contains no definition of the term "amendment". Thus, it could be argued that any process modification in a facility--no matter how insignificant the change--will force a licensee to comply with the application and environmental report requirements of RH § 3.8. Commentors urge that RH § 3.17 be revised to include a definition of the term "amendment", and that this concept be limited to process changes of sufficient significance to warrant the expense and delay incidental to the processing of an application under RH § 3.8.

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IV. COMMENTS ON PROPOSED PART III, SCHEDULE E, OF THE REGULATIONS.

These comments will follow a slightly different format. Proposed deletions from the proposed rule are slashed, and proposed additions are underlined.

CRITERION 1

(a) In selecting among alternative tailings disposal sites ~~or judging the adequacy of existing tailings sites~~, the following site features which would assure meeting the broad objective of ~~isolating the tailings and associated contaminants from man and the environment in the short term and for thousands of years without ongoing active maintenance~~ reducing harmful emissions from the tailings during operations and over the long-term without ongoing regular maintenance shall be considered:

(1) Remoteness from populated areas:

(2) Hydrogeologic and other environmental conditions conducive to continued immobilization and isolation of contaminants from usable groundwater sources: and

(3) Potential for minimizing erosion, disturbance, and dispersion by natural forces over the long term.

(b) The site selection process shall be an optimization to the maximum extent reasonably achievable in terms of these features.

(c) In the selection of disposal sites, primary emphasis shall be given to isolation of tailings or wastes, a matter having long-term impacts, as opposed to consideration only of short-term convenience or benefits, such as minimization of transportation or land acquisition costs. While isolation of tailings will be a function of both site characteristics and engineering design, overriding consideration shall be given to siting features given the long-term nature of the tailings hazards.

(d) Tailings shall be disposed of in a manner such that no active maintenance is required to preserve the condition of the site.

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COMMENT:

The first deletion is suggested as application of this criterion retroactively to existing sites is not appropriate or lawful. This criterion could not have been anticipated or planned for at existing sites and could easily destroy the economic viability of existing projects, especially considering the present economic state of the uranium industry. How would it be possible to make any selection when the site is already in use?

The second deletion and addition are made as this more concisely states the reasonable broad objective of tailings stabilization. A regulation that calls for actions to be effective for thousands of years is unrealistic. In its proposed disposal standards for inactive uranium processing sites (46 F.R. 2556, January 9, 1981), EPA has recognized the impracticality of the imposition of remedial action standards for periods in excess of one thousand years (see EPA's comments on proposed rules, 46 F.R. at 2560) particuarly where, as here, site-specific evaluation of the need for a longer period is not present. In comments on remedial action for uranium processing sites (40 CFR 192) prepared by Robley D. Evans at the invitation of Dr. William A. Mills (Director, Criteria and Standards Division, Office of Radiation Programs, U.S. EPA) Evans points out that "even 100 to 200 years seems more than an adequate time span".

Evans also states that, "Disposal" without any form of occasional surveilance is impracticable. "Management", not "disposal", is a more realistic plan". Dr. Evans said in a telephone call that "surveilance" included inspection and maintenance.

It should be noted that uranium mill tailings constitute only a potential hazard. While they contain some toxic materials, they are not hazardous unless the toxic components reach human subjects.

CRITERION 2

To avoid proliferation of small waste disposal sites, radioactive material from ~~in situ extraction operations, such as residues from solution evaporation or contaminated control processes, and wastes from~~ small remote above ground extraction operations shall preferably be disposed of at existing large mill tailings disposal sites: unless, considering the nature of the wastes, such as their volume

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and specific activity and the costs and environmental impacts of transporting the wastes to a large disposal site, such offsite disposal is demonstrated to be impracticable or the advantage of onsite burial ~~clearly~~ outweigh the benefits of reducing the perpetual surveillance obligations.

COMMENT:

The criterion is clear enough without these excess words. When attempting to apply this criterion to a specific site, several facts must be considered. Operators of in-situ and small remote above-ground extraction operations may not also operate existing large mills. Therefore, before their wastes could be disposed of at the tailings disposal sites of large mills, the operators of the mills would have to be persuaded to accept them. Questions of proportionate costs and liability would have to be considered. Existing mills may have planned for only enough tailings capacity for the tailings from their mills. Also, the wastes from the small sites may not be compatible and could lead to instability of the tailings impoundments.

CRITERION 3

~~The "Prime Option" for disposal of tailings is placement below grade, either in mines or specially excavated pits.~~

In order to meet the objective of reducing harmful emissions from tailing areas during operations and over the long-term, the evaluation of alternative sites and disposal methods performed by mill operators in support of their proposed tailings disposal program shall reflect serious consideration of ~~the disposal mode~~ full or partial placement below grade, as appropriate. In some instances below-grade disposal may not be the most environmentally sound approach, such as might be the case if a high quality groundwater formation is relatively close to the surface or not very well isolated by overlying soils and rock. Also, geologic and topographic conditions might make full, below-grade burial impracticable: for example, bedrock may be sufficiently near the surface that blasting would be required to excavate a disposal pit at excessive cost, and more suitable alternate sites are not available. ~~Where full below grade burial is not practicable, the size of retention structures, and size and steepness of slopes of associated exposed embankments,~~

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~~shall be minimized by excavation to the maximum extent reasonably achievable or appropriate given the geologic and hydrogeologic conditions at a site. In these cases, it must be demonstrated that an above-grade disposal program will provide reasonably equivalent isolation of the tailings from natural erosional forces.~~

COMMENT:

We have stated the health goal to be achieved in the first addition and have removed reference to a "prime option". Establishing a "prime option" is not appropriate since it creates a presumption in favor of one technique for tailings disposal. The criterion should only require disposal adequate to meet the health goal, through the use of whatever method is most suitable for each specific site. The mill license applicant should not be required to compare and contrast other techniques that are not suitable to the specific mill site.

We have deleted the last portion of the proposed criterion as the department has created a "Catch 22" which should be removed. In cases where below grade disposal is impracticable, the alternative method must provide "reasonably equivalent isolation of the tailings". However, if below grade disposal is impracticable, it literally cannot be accomplished and therefore, there is no way of determining if the alternative disposal method provides "reasonably equivalent isolation of the tailings".

CRITERION 4

The following site and design criteria shall be adhered to whether tailings or wastes are disposed of above or below grade:

(a) Upstream rainfall catchment areas must be minimized to decrease erosion potential and the size of the maximum possible flood.

(b) Topographic features shall provide good wind protection.

(c) Embankment and cover slopes shall be relatively flat after final stabilization to minimize erosion potential and provide conservative factors of safety assuring long-term stability. The broad objective should be to contour final slopes to

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grades which are as close as possible to these which would be provided if tailings were disposed of below grade: this could, for example, lead to slopes of about 10 horizontal to 1 vertical (10h:1v) or less steep. In general, slopes should not be steeper than about ~~5H/1V~~ <u>2.5h:1v</u>. Where steeper slopes are proposed, reasons why a slope less steep would be impracticable should be provided, and compensating factors and conditions which make such slopes acceptable should be identified.

(1) Where a full vegetative cover is not likely to be self-sustaining due to climatic conditions, such as in semi-arid and arid regions, rock cover shall be employed on slopes of the impoundment system. The Department will consider relaxing this requirement for extremely gentle slopes such as those which may exist on the top of the pile.

(2) The following factors shall be considered in establishing the final rock cover design to avoid displacement of rock particles by human and animal traffic or by natural processes, and to preclude undercutting and piping:

(a) Shape, size, composition, gradation of rock particles, excepting bedding material, average particle size shall be at least cobble size or greater:

(b) Rock cover thickness and zoning of particles by size: and

(c) Steepness of underlying slopes.

(3) ~~Individual rock fragments shall be dense, sound, and resistant to abrasion, and shall be free from cracks, seams, and other defects that would tend to unduly increase their destruction by water and frost actions. Shale, rock laminated with shale, and cherts shall not be used.~~ <u>Site specific erosion standards shall be established for each license which will allow the use of native rock fragments in a manner and amount to the end that erosion will be minimized</u>.

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(4) Rock covering of slopes may not be required where top covers are very thick, on the order of 10 meters or greater: impoundment slopes are very gentle on the order of 10h:1v or less: bulk cover materials have inherently favorable erosion resistance characteristics: and there is negligible drainage catchment area upstream of the pile, and there is good wind protection as described in points (a) and (b) of the criterion.

(5) Furthermore, all impoundment surfaces shall be contoured to avoid areas of concentrated surface runoff or abrupt or sharp changes in slope gradient. In addition to rock cover on slopes, areas toward which surface runoff might be directed shall be well protected with substantial rock cover or rip rap. In addition to providing for stability of the impoundment systems itself, overall stability, erosion potential, and geomorphology of surrounding terrain shall be evaluated to assure that there are no ongoing or potential processes, such as gully erosion, which would lead to impoundment instability.

(e) The impoundment shall not be located near a capable fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand. As used in this criterion, the term "capable fault" has the same meaning as defined in section III(g) of Appendix A of 10 CFR Part 100. The term "maximum credible earthquake" means that earthquake which would cause the maximum vibratory ground motion based upon an evaluation of earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material.

(f) The impoundment, where feasible, should be designed to incorporate features which will promote deposition. For example, design features which promote deposition of sediment suspended in any runoff which flows into the impoundment area might be utilized; the object of such a design

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feature would be to enhance the thickness of cover over time.

COMMENT:

A. Criterion 4 specifies several "site and design criteria" which "shall be adhered to whether tailings or wastes are disposed of above or below grade." The various criteria are contradictory in part. For example, one criterion requires that "upstream rainfall catchment areas must be minimized," while another provides that "topographic features should provide good wind protection." The best, and perhaps only, way to minimize upstream catchment areas is to place tailings on mesas or other elevated sites. Such sites, of course, do not provide good wind protection. This contradiction should be resolved by assigning relative weights or preferences to the two factors, given the site specific features of the applicant's proposed mill site and proposed alternatives thereto.

B. The requirement of Criterion 4 that slopes be no steeper than 5h:1v is unreasonable and unsupported. Depending upon the nature of the layers of cover and natural surrounding topographic features, slopes of 2½h:1v will provide adequate protection against erosion. Additionally, the establishment of a vegetative cover will significantly reduce erosion potential.

C. The specifications for "individual rock fragments" to be used in the rock cover required by Criterion 4 are unreasonable and unrealistic. For example, the criterion forbids the use of "weak, friable, or laminated aggregate" or "shale, rock laminated with shale, and cherts". In many areas surrounding existing mills, the only native rock cover reasonably available is "friable" (e.g., sandstone) "laminated aggregate," or "shale (or) rock laminated with shale." These specifications should be deleted and an erosion performance standard substituted for them which will simply allow licensees to use native rock fragments in whatever manner and amounts they find necessary to meet that standard.

CRITERION 7

(a) ~~Milling operations shall be conducted so~~ Mill operators should make every reasonable effort to assure that all airborne effluent releases are reduced to as low as is reasonably achievable. The primary means of accomplishing this shall be by means of emission controls. Institutional

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controls, such as extending the site boundary and exclusion area, may be employed to ensure that offsite exposure limits are met but only after all practicable measures have been taken to control emissions at the source. ~~Notwithstanding the existence of individual dose standards, strict control of emissions is necessary to assure that population exposures are reduced to the maximum extent reasonably achievable and to avoid site contamination. The greatest potential source of offsite radiation exposure (aside from radon exposure) are dusting from dry surfaces of the tailings disposal area not covered by tailings solution and emissions from yellowcake drying and packaging operations.~~ Checks shall be made and ~~logged hourly~~ recorded periodically of all parameters, that is differential pressure and scrubber water flow rate, which determine the efficiency of yellowcake stack emission control equipment operations. It shall be determined whether or not conditions are within a range prescribed to ensure that the equipment is operating consistently near peak efficiency; corrective action shall be taken when performance is outside of prescribed ranges. In lieu of ~~hourly checks~~ periodic recordation, the use of monitoring devices with alarms will be considered if the devices monitor all appropriate parameters and are calibrated and checked on a schedule approved by the department. Effluent control devices shall be operative at all times during drying and packaging operations and whenever air is exhausting from the yellowcake stack.

(b) Drying and packaging operations shall terminate when controls are inoperative. When checks indicate the equipment is not operating within the range prescribed for peak efficiency, actions shall be taken to restore parameters to the prescribed range. When this cannot be done without shutdown and repairs, drying and packaging operations shall cease as soon as practicable.

(c) Operations may not be re-started after cessation due to off-normal performance until needed corrective actions have been identified and implemented, unless a restart is necessary to identify the needed corrective actions. All such cessations, corrective actions, and re-starts shall be ~~reported to the department in writing, within 10 days of the subsequent start~~ documented for review by department personnel during routine inspections.

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(d) To control dusting from tailings, that portion not covered by standing liquids shall be wetted or chemically stabilized to prevent or minimize blowing and dusting to the maximum extent reasonably achievable. This requirement may be relaxed if tailings are effectively sheltered from wind, such as may be the case where they are disposed of below grade and the tailings surface is not exposed to wind. Consideration shall be given in planning tailings disposal programs to methods which would allow phased covering and reclamation of tailings impoundments since this will help in controlling particulate and radon emissions during operation. To control dustings from diffuse sources, such as tailings and ore pads where automatic controls do not apply, operators shall develop written operating procedures specifying the methods of control which will be utilized.

COMMENT:

The sentences on dose standards, population doses and potential sources of exposure proposed by the Department of Health are simply editorial comment and add nothing substantive to the criterion.

Hourly logging of scrubber parameters is unreasonable and unnecessary. The recovery of yellowcake from the scrubbing system provides a significant incentive for mill operators to maintain scrubbers at peak efficiency. More importantly, though, diversion of mill personnel's attention from operations to "logging" may result in greater risk to public health.

The yellowcake drying and packaging operations could quite possibly be shut down when control equipment is malfunctioning before the cause and corrective actions are identified. It then might be necessary to restart the operations in order to identify them. We have added this option.

The increased paperwork of the 10-day written notification is not justified. Plant personnel should be allowed to concentrate on correcting or preventing problems.

CRITERION 8

These criteria relating to ownership of tailings and their disposal sites become effective on November 8, 1981, and apply to all licenses terminated, issued, or renewed after that date.

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(a) Any uranium or thorium milling license or tailings license shall contain such terms and conditions as the U.S. Nuclear Regulatory Commission and Department determine are necessary to assure that prior to termination of the license, the licensee will comply with ownership requirements of this criterion for sites used for tailings disposal.

(b) Title to the byproduct material license pursuant to 3.10.6 and land, including any interest therein (other than land owned by the United States or by a State) which is used for the disposal of any such byproduct material, ~~or is essential to ensure the long term stability of such disposal site,~~ shall be transferred to the United States or the state in which such land is located, at the option of the state. In view of the fact that physical isolation must be the primary means of long term control, and government land ownership is a desirable supplementary measure, ownership of certain severable subsurface interests, for example, mineral rights, may be determined to be unnecessary to protect the public health and safety and the environment. ~~In any case, however, the applicant operator must demonstrate a serious effort to obtain such subsurface rights, and must, in the event that certain rights cannot be obtained, provide notification in local public land records of the fact that the land is being used for the disposal of radioactive material and is subject to either a U.S. Nuclear Regulatory Commission general or specific license prohibiting the disruption and disturbance of the tailings.~~ In some rare cases, such as may occur with deep burial where no ongoing site surveillance will be required, surface land ownership transfer requirements ~~may~~ shall be waived. For licenses issued before November 8, 1981, the department ~~may~~ shall take into account the status of the ownership of such land, and interest therein and the ability of a licensee to transfer title and custody thereof to the United States or the state. Subsequent renewals shall not disqualify licensees otherwise eligible for such consideration under this criterion.

(c) The state may permit use of the surface or subsurface land transferred to it if the

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U.S. Nuclear Regulatory subsequent to title transfer determines that use of the surface or subsurface estates, or both, of the land transferred to the United States or the state will not endanger the public health, safety, welfare, or environment: The U.S. Nuclear Regulatory Commission may permit the use of the surface or subsurface estates, or both, of such land in a manner consistent with the provisions provided in these criteria. If the U.S. Nuclear Regulatory Commission permits such use of such land, it will provide the person who transferred such land with the right of first refusal with respect to such use of such land.

(d) Material and land transferred to the United States or the state in accordance with this criterion shall be transferred without cost to the United States or the state other than administrative and legal costs incurred in carrying out such transfer.

(e) The requirements for transfer of title and custody to land and tailings and waste shall not apply in the case of lands held in trust by the United States for any Indian tribe or lands owned by such Indian tribe subject to a restriction against alienation imposed by the United States. In the case of such lands which are used for the disposal of byproduct material, as defined in RH 1.6, the licensee shall enter into arrangements with the U.S. Nuclear Regulatory Commission as may be appropriate to assure the long term surveillance of such lands by the United States.

COMMENT:

The requirement that the licensee transfer title not only to product material and land which is used for the disposal of such material, but also to land essential to insure the long-term stability of such disposal site, is vague, overbroad and unsupported in the Uranium Mill Tailings Radiation Control Act (UMTRCA).

The requirement that a licensee must demonstrate a serious effort to obtain subsurface rights even if they are not necessary to protect the public health and safety is arbitrary and has no support in UMTRCA.

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Criterion 8(b) & (d) provide that upon decommissioning, title to land used for tailings disposal shall be transferred to the government of the United States or of an Agreement state without cost to that government. This constitutes a taking without just compensation and without due process contrary to the Fifth Amendment (and, if a state is involved, the Fourteenth Amendment) to the United States Constitution. The provision should be altered to provide that just compensation for the property and estate(s) conveyed shall be paid to the decommissioning licensee. At the very least, subdivision (c) should be revised to make clear that if the Commission should determine, after a licensee's decommissioning and conveyance of the site to the government, that any use of any surface or subsurface estate is allowable, a right of first refusal of such use <u>at no cost</u> shall be provided the conveying licensee.

CERTIFICATE OF MAILING

I certify that a copy of "Comments on Proposed Revisions to Colorado Radiation Control Regulations and Related Documents" were mailed June 5, 1981, with postage prepaid to the following Board of Health Members:

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National Jewish Hospital
Colfax & Colorado Blvd.
Denver, CO 80206

Al Hayden
Pueblo County Courthouse
Tenth and Main
Pueblo, CO 81003

Amilu Martin
2140 East LaSalle Street
Colorado Springs, CO 80909

Gatewood Milligan
3191 South Broadway
Englewood, CO 80110

Charles Mitchell
3455 Gaylord
Denver, CO 80205

Carol Rushold
Lower Valley Hospital
228 North Cherry
Fruita, CO 81521

Robert Sabin
P.O. Box 490
LaJunta, CO 81050

Linda Shaw
2193 South Estes Way
Lakewood, CO 80227

Done this 5th day of June, 1981.

KIRKLAND & ELLIS

By Belva J. Woodend
Belva J. Woodend
1625 Broadway
Denver, Colorado 80202

The Colorado MINING ASSOCIATION

DAVID R. COLE
Secretary and Manager

June 17, 1981

Radiation and Hazardous Wastes
Control Division
Colorado Department of Health
4210 E. 11th Avenue
Denver, Colorado 80220

Attention: Frank A. Traylor, M.D.
Executive Secretary, Colorado
Board of Health

Re: Supplemental Comments on Proposed Revisions to Colorado Radiation Control Regulations and Related Documents

Dear Dr. Traylor:

Attached are supplemental comments submitted on behalf of the Colorado Mining Association and the members of that Association which are or which contemplate engaging in uranium milling in the state of Colorado. Comments were presented to all Board of Health members and to the Department on June 5, 1981 focusing on the major portions of the proposed rules. These supplemental statements focus on items not covered in the June 5 set, including:

1. The fee schedule for licenses;

2. Proposed R.H. 3.9.5.4.2 concerning long-term funding; and

3. Criteria 5 and 6 of proposed Part III, Schedule E, of the rules.

Thank you for the opportunity to present our comments.

Very truly yours,

David R. Cole

David R. Cole

DRC/z

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COMMENTS ON FEE SCHEDULE FOR RADIOACTIVE MATERIALS LICENSES AND OTHER REGULATORY SERVICES

We request that a statement be included with the fee schedule which provides that the revised fee schedule shall not be retroactive in application; i.e., new license or license renewal applicants who have already paid their license fees as established under the old regulations will not have to pay an additional sum.

Retrospective application of the revised license fee schedule would violate the prohibition against retrospective legislation and rule making contained in the Colorado Constitution. Article II, Section 11 of the Colorado Constitution states that "no ... law ... retrospective in its operation ... shall be passed by the General Assembly." This constitutional provision has been interpreted to prohibit legislation which takes away or impairs any vested rights acquired under existing laws, creates a new obligation, imposes a new duty, or attaches a new disability, in respect to transactions or considerations already passed. See, e.g., Peoples Natural Gas v. Public Utilities Commission, ___ Colo. ___, 590 P.2d 960 (1979); Moore v. Livestock Company, 90 Colo. 548, 10 P.2d 950 (1932); and Denver South Park Pacific Railway Company v. Woodward, 4 Colo. 162 (1878).

Since the General Assembly is prohibited from enacting retrospective legislation, this prohibition must also extend to rulemaking by administrative agencies, since such rule making is accomplished pursuant to authorizing statutes. See, e.g., Dixon v. Zick, 179 Colo. 278, 500 P.2d 130 (1972).

According to the "Fiscal Impact Statement" the license fees are being increased to cover the costs of other state agencies which participate in the license review. To the extent these "other agencies" are not authorized by statute to collect license or service fees, the proposed revised fee schedule is not authorized by any underlying statute, and is invalid.

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Supplemental Comments to:

RH §3.9.5.4.2:

A fund shall be established based on Department approved cost estimates, and for source material milling operations shall not be less than $250,000 (1978 dollars). The funds provided by the licensee shall yield interest in an amount sufficient to cover the average annual cost of monitoring and maintenance of the site based on an assumed 1% annual real interest rate. An annual review of the inflation rate and interest yield will be accomplished by the Department and necessary changes made in the long-term care agreement with the licensee. The inflation rate to be used is that indicated by the change in the Consumer Price Index published by the U.S. Department of Labor, Bureau of Labor Statistics.

PROPOSED REVISIONS:

A fund shall be established based on Department approved cost estimates, after consultation with the licensee. The fund shall not in any event be less than $250,000, EXCEPT THAT A LESSER CHANGE SHALL BE CONSIDERED, WHERE APPROPRIATE, FOR SMALL OPERATIONS (E.G., HEAP LEACH OR IN SITU OPERATIONS). The funds provided by the licensee shall yield interest in an amount sufficient to cover the average annual cost of monitoring and maintenance of the site based on an assumed 2% annual real interest rate. An annual review of the inflation rate and interest yield will be accomplished by the Department and necessary changes made in consultation with the licensee in the long-term care agreement with the licensee.

COMMENT:

We have requested a limited exception to the "minimum charge rule" of $250,000 in cases where the subject facility is not a typical uranium milling operation. We believe the NRC criterion #10 did not take into consideration the fact that long-term surveillance of a reclaimed heap-leach operation will require a much less extensive range of activities than that required for a typical mill. Consequently, an exception should be provided to the minimum charge figure in cases where

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the licensed facility is a small heap-leach operation or of a similar nature.

As stated in the comments submitted on June 5, 1981, CMA herewith submits the following data in support of the 2% annual real interest rate, which has been submitted in lieu of the 1% rate proposed in the regulations.

Indices

	Approximate Average Annual Rate of Change		
	1951-1980	1971-1980	1976-1980
INFLATION INDEX			
. Implicit Price Deflator, GNP	4.1	6.9	6.9
EARNING (INTEREST) INDEX			
. Domestic Corporate Bond Yields	6.2	9.2	10.0

PUBLISHED SOURCE U. S. DEPT. OF LABOR, BUREAU OF LABOR STATISTICS

. IMPLICIT PRICE DEFLATOR - current - weighted price indexes derived by dividing the current-dollar GNP by the constant-dollar GNP.

DOMESTIC CORPORATE BOND YIELDS - MOODY'S INVESTORS SERVICES

. The overall corporate yield average is the average of the four rating classifications (Aaa, Aa, A, Baa) and is also the average of the three groups (railroad, public utility, and industrial).

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COMMENTS ON CRITERIA 5 and 6 OF PROPOSED PART III, SCHEDULE E, OF THE REGULATIONS.

The format of these comments consists of proposed deletions from the proposed criteria designated by ~~dashes~~ and proposed additions underlined. A comment section follows each criteria.

CRITERION 5

(a) STEPS SHALL BE TAKEN TO REDUCE SEEPAGE OF TOXIC MATERIALS INTO GROUNDWATER TO THE MAXIMUM EXTENT ~~REASONABLY ACHIEVABLE~~ PRACTICABLE. ANY SEEPAGE WHICH DOES OCCUR SHALL NOT RESULT IN DETERIORATION OF EXISTING GROUNDWATER SUPPLIES FROM THEIR CURRENT OR POTENTIAL USE. THE FOLLOWING SHALL BE CONSIDERED TO ACCOMPLISH THIS:

(1) INSTALLATION OF LOW PERMEABILITY BOTTOM LINERS. WHERE SYNTHETIC LINERS ARE USED, A LEAKAGE DETECTION SYSTEM SHALL BE INSTALLED IMMEDIATELY BELOW THE LINER TO ENSURE MAJOR FAILURES ARE DETECTED IF THEY OCCUR. THIS IS IN ADDITION TO THE GROUNDWATER MONITORING PROGRAM CONDUCTED AS PROVIDED IN RH 3.10.6.2 WHERE CLAY LINERS ARE PROPOSED OR RELATIVELY THIN IN-SITU CLAY SOILS ARE TO BE RELIED UPON FOR SEEPAGE CONTROL, TESTS SHALL BE CONDUCTED WITH REPRESENTATIVE TAILINGS SOLUTIONS AND CLAY MATERIALS TO CONFIRM THAT NO SIGNIFICANT DETERIORATION OF PERMEABILITY OR STABILITY PROPERTIES WILL OCCUR WITH CONTINUOUS EXPOSURE OF CLAY TO TAILINGS SOLUTIONS. TESTS SHALL BE RUN FOR A SUFFICIENT PERIOD OF TIME TO REVEAL ANY EFFECTS IF THEY ARE GOING TO OCCUR.

(2) MILL PROCESS DESIGN WHICH PROVIDES THE MAXIMUM PRACTICABLE RECYCLE OF SOLUTIONS AND CONSERVATION OF WATER TO REDUCE THE NET INPUT OF LIQUID TO THE TAILINGS IMPOUNDMENT.

(3) DEWATERING OF TAILINGS BY PROCESS DEVICES AND/OR IN-SITU DRAINAGE SYSTEM. AT NEW SITES, TAILINGS SHALL BE DEWATERED BY A DRAINAGE SYSTEM INSTALLED AT THE BOTTOM OF THE IMPOUNDMENT TO LOWER THE PHREATIC SURFACE AND REDUCE THE DRIVING HEAD FOR SEEPAGE, UNLESS TESTS SHOW TAILINGS ARE NOT AMENDABLE TO SUCH A SYSTEM. WHERE

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IN-SITU DEWATERING IS TO BE CONDUCTED, THE IMPOUNDMENT BOTTOM SHALL BE GRADED TO ASSURE THAT THE DRAINS ARE AT A LOW POINT. THE DRAINS SHALL BE PROTECTED BY SUITABLE FILTER MATERIALS TO ASSURE THAT DRAINS REMAIN FREE RUNNING. THE DRAINAGE SYSTEM SHALL SLAO BE ADEQUATELY SIZED TO ASSURE GOOD DRAINAGE.

(4) CHEMICALLY PROMOTE IMMOBILIZATION OF TOXIC SUBSTANCES.

(b) WHERE GROUNDWATER IMPACTS ARE OCCURING AT AN EXISTING SITE DUE TO SEEPAGE, ACTION SHALL BE TAKEN TO ALLEVIATE CONDITIONS THAT LEAD TO EXCESSIVE SEEPAGE IMPACTS OR TO PREVENT SIGNIFICANT MIGRATION OF CONTAMINANTS ~~AND RESTORE GROUNDWATER QUALITY TO ITS POTENTIAL USE BEFORE MILLING OPERATIONS BEGAN~~ TO THE MAXIMUM EXTENT PRACTICABLE. THE SPECIFIC SEEPAGE CONTROL AND GROUNDWATER PROTECTION METHOD, OR COMBINATION OF METHODS, TO BE USED MUST BE WORKED OUT ON A SITE-SPECIFIC BASIS. TECHNICAL SPECIFICATIONS SHALL BE PREPARED TO CONTROL INSTALLATION OF SEEPAGE CONTROL SYSTEMS. A QUALITY ASSURANCE, TESTING, AND INSPECTION PROGRAM, WHICH INCLUDES SUPERVISION BY A QUALIFIED ENGINEER OR GEOLOGIST, SHALL BE ESTABLISHED TO ASSURE THAT SPECIFICATION IS MET. PROVIDED, THAT THE PROVISIONS OF THIS CRITERION 5 SHALL NOT APPLY IN SITUATIONS WHERE SAND BACKFILL TO UNDERGROUND MINES EMPLOYS MILL TAILINGS.

(c) WHILE THE PRIMARY METHOD OF PROTECTING GROUNDWATER SHALL BE ISOLATION OF TAILINGS AND TAILINGS SOLUTIONS, DISPOSAL INVOLVING CONTACT WITH GROUNDWATER WILL BE CONSIDERED PROVIDED SUPPORTING TESTS AND ANALYSIS ARE PRESENTED DEMONSTRATING THAT THE PROPOSED DISPOSAL AND TREATMENT METHODS WILL NOT DEGRADE GROUNDWATER FROM CURRENT OR POTENTIAL USES.

(d) FURTHERMORE, STEPS SHALL BE TAKEN DURING STOCKPILING OF ORE AT MILLS TO MINIMIZE PENETRATION OF RADIONUCLIDES INTO UNDERLYING SOILS: SUITABLE METHODS INCLUDE LINING AND/OR COMPACTION OF ORE STORAGE AREAS. THIS PROVISION SHALL NOT APPLY TO ORE STOCKPILES AT MINING OPERATIONS.

(e) IN SUPPORT OF A TAILINGS DISPOSAL SYSTEM PROPOSAL, THE APPLICANT/OPERATOR SHALL SUPPLY INFORMATION CONCERNING THE FOLLOWING:

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(1) THE CHEMICAL, PHYSICAL AND RADIOACTIVE CHARACTERISTICS OF THE WASTE SOLUTIONS.

(2) THE CHARACTERISTICS OF THE UNDERLYING SOIL AND GEOLOGIC FORMATIONS PARTICULARLY THE EXTENT TO WHICH THEY WILL CONTROL TRANSPORT OF CONTAMINANTS AND SOLUTIONS. THIS SHALL INCLUDE DETAILED INFORMATION CONCERNING EXTENT, THICKNESS, UNIFORMITY, SHAPE, AND ORIENTATION OF UNDERLYING THICKNESS STRATA. HYDRAULIC GRADIENTS AND CONDUCTIVITIES OF THE VARIOUS FORMATIONS SHALL BE DETERMINED. THIS INFORMATION SHALL BE GATHERED BY BORINGS AND FIELD SURVEY METHODS TAKEN WITHIN THE PROPOSED IMPOUNDMENT AREA AND IN SURROUNDING AREAS WHERE CONTAMINANTS MIGHT MIGRATE TO USABLE GROUNDWATER. THE INFORMATION GATHERED ON BOREHOLES SHALL INCLUDE BOTH GEOLOGIC AND GEOPHYSICAL LOGS IN SUFFICIENT NUMBER AND DEGREE OF SOPHISTICATION TO ALLOW DETERMINING SIGNIFICANT DISCONTINUITIES, FRACTURES, AND CHANNELED DEPOSITS WHICH ARE OF HIGH HYDRAULIC CONDUCTIVITY. IF FIELD SURVEY METHODS ARE USED, THEY SHOULD BE IN ADDITION TO AND CALIBRATED WITH BOREHOLD LOGGING. HYDROLOGIC PARAMETERS SUCH AS PERMEABILITY SHALL NOT BE DETERMINED ON THE BASIS OF LABORATORY ANALYSIS OF SAMPLES ALONG: A SUFFICIENT AMOUNT OF FIELD TESTING SHALL BE CONDUCTED TO ASSURE ACTUAL FIELD PROPERTIES ARE ADEQUATELY UNDERSTOOD. TESTING SHALL BE CONDUCTED TO ALLOW ESTIMATING CHEMI-SORPTION ATTENUATION PROPERTIES OF UNDERLYING SOIL AND ROCK.

(3) LOCATION, EXTENT, QUALITY AND CAPACITY OF ANY GROUNDWATER AT AND NEAR THE SITE.*

<u>COMMENT</u>:

A. The burden imposed by Criterion 5 on operators of existing disposal sites to alleviate conditions leading to "excessive seepage impacts" and to "restore groundwater quality to its potential use before milling

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* In addition to the specific revisions suggested above, please see comments provided below which suggest more revisions.

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operators began to the maximum extent practicable" is unduly vague. The provision should make clear the meaning of the threshold conditions (i.e., "groundwater impacts" and "excessive seepage impacts") which must be present before any action is required, as well as the method for determining what "potential uses" existed originally. Moreover, the regulation should clearly emphasize that corrective action is to be required only to the "extent practicable" and that undertakings, the expense of which plainly outweighs the benefits, are not within that scope.

B. Criterion 5 should not apply to stockpiles of ore located at mines as mining operations are outside the scope of UMTRCA.

C. Criterion 5 calls for steps to be taken "to reduce seepage of toxic materials into groundwater to the maximum extent reasonably achievable. Any seepage which does occur shall not result in deterioration of existing groundwater supplies from their current or potential uses." EPA regulations promulgated under the Safe Drinking Water Act (SDWA) adopt the concept of "exempted aquifers." Release of effluents to an exempted aquifer is not subject to the stringent regulations otherwise applied under the SDWA regulations. Criterion 5 should be reformulated in a fashion consistent with the exempted aquifer concept under the SDWA. As it stands, the criterion is unnecessarily preclusive and unreasonable.

D. Criterion 5 states that "the primary method of protecting groundwater shall be isolation of tailings and tailings solutions" and provides further that "disposal involving contact with groundwater will be considered provided supporting tests and analyses are presented demonstrating that the proposed disposal and treatment methods will not degrade groundwater from current or potential uses." Most sand backfill in uranium mines occurs in aquifers containing groundwater. Sand backfill necessarily employs mill tailings. Criterion 5, as promulgated, creates a presumption against sand backfill employing such tailings. This result is arbitrary and unreasonable. Sand backfill is essential to prevent roof cave ins (which damage overlying aquifers) and to enhance worker safety (by

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stabilizing mined-out stopes). Sand backfill employing mill tailings should be allowed without restriction.

E. As set forth in Criterion 5 of the Proposal and Final Regulations on Uranium Mill Tailings Licensing and Criteria as published in the Federal Register on August 24, 1979 (also Criterion 5 in the Department's proposed regulations), and in Chapter 12 of the Generic Environmental Impact Statement on Uranium Milling (GEIS) recommendations are made concerning proposed regulatory actions for uranium mill tailings disposal. Under Item No. 6 in Chapter 12 of the GEIS the statement set forth below was made:

> "Steps should be taken to reduce seepage of toxic materials into the groundwater to the maximum extent reasonably achievable. This could be accomplished by lining the bottom of the tailings area and reducing the inventory of the liquid impoundment by such means as dewatering tailings and recycling water from the tailings impoundments to the mill. Furthermore steps should be taken during stockpiling of ore to minimize penetration of radionuclides in the underlying soils; suitable methods include lining and/or compaction of ore storage areas." "The specific method, or combination of methods to be used must be worked out on the site-specific basis. While the primary method of protecting groundwater should be by isolation of tailings and tailings solutions, disposal involving contact with the groundwater will be considered by the staff provided supporting tests and analysis are presented demonstrating that the proposed disposal and treatment methods will preserve quality of groundwater."

The date presented in the GEIS do not support the contention that isolation of tailings and tailings solutions should be the primary method of tailings disposal. Rather, the emphasis should be placed on utilizing the site-specific characteristics of the disposal

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area in an effort to select the best tailings management system for groundwater protection.

CRITERION 6

SUFFICIENT EARTH COVER, BUT NOT LESS THAN THREE METERS, SHALL BE PLACED OVER TAILINGS OR WASTES AT THE END OF MILLING OPERATIONS TO RESULT IN A CALCULATED REDUCTION IN SURFACE EXHALATION OF RADON EMANATING FROM THE TAILINGS OR WASTES TO LESS THAN TWO PICOCURIES PER SQUARE METER PER SECOND ABOVE NATURAL BACKGROUND LEVELS. IN COMPUTING REQUIRED TAILINGS COVER THICKNESSES, MOISTURE IN SOILS IN EXCESS OF AMOUNTS FOUND NORMALLY IN SIMILAR SOILS IN SIMILAR CIRCUMSTANCES SHALL NOT BE CONSIDERED. DIRECT GAMMA EXPOSURE FROM THE TAILINGS OR WASTES SHOULD BE REDUCED TO BACKGROUND LEVELS. THE EFFECTS OF ANY THIN SYNTHETIC LAYER SHALL NOT BE TAKEN INTO ACCOUNT IN DETERMINING THE CALCULATED RADON EXHALATION LEVEL. IF NON-SOIL MATERIALS ARE PROPOSED TO REDUCE TAILINGS COVERS TO LESS THAN THREE METERS, IT MUST BE DEMONSTRATED THAT SUCH MATERIALS WILL NOT CRACK OR DEGRADE BY DIFFERENTIAL SETTLEMENT, WEATHERING, OR OTHER MECHANISM OVER LONG TERM TIME INTERVALS. NEAR SURFACE MATERIALS, THAT IS WITHIN THE TOP THREE METERS, SHALL NOT INCLUDE MINE WASTE OR ROCK THAT CONTAINS ELEVATED LEVELS OF RADIUM: SOILS USED FOR NEAR SURFACE COVER MUST BE ESSENTIALLY THE SAME, AS FAR AS RADIOACTIVITY IS CONCERNED, AS THAT OF SURROUNDING SOILS.

(Note: see Comments below and Appendix 6 attached hereto.)

COMMENT:

A. Criterion 6 requires sufficient earth cover over decommissioned tailings piles to reduce surface exhalation of radon from the piles to "less than two picocuries per square meter per second" (2 $pCi/m^2/sec.$). The preamble to the regulations (45 Fed. Reg. 65528) and the final GEIS (e.g., Vol. I, P. 12-11; Vol. II, p.A-103) clearly state that radon exhalation is to be limited to less than 2 $pCi/m^2/sec.$ "above background" levels. Criterion 6 should be clarified to indicate that the radon exhalation limit refers to exhalation above natural background levels, as opposed to an absolute quantified limit.

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B. The 2 pCi/m^2/sec. radon exhalation limit and the three-meter earth cover requirement, designed to effectuate that limit, are unreasonabl and not supported by record evidence of cost-effectiveness. First, CDH essentially abdicated its responsibility to provide reasoned, analytical support for either requirement. The Department failed to select a reasonable period over which to integrate postulated health effects and refused to assign monetary values to those health effects or even to attempt a cost-benefit analysis of the requirements. Moreover, the NRC, in the Generic Environmental Impact Statement, seriously underestimated the cost and availability of cover materials to satisfy its requirements. These requirements are unreasonable, arbitrary and capricious and unsupported by the record. (see Appendix 6 attached)

C. The earth cover requirements for long-term control of radon exhalation specified in Criterion 6 are needlessly inflexible and design-restrictive. Reduction of radon exhalation to prescribed levels above background should be stated in terms of performance standards and the methods of achieving compliance left to industry and individual licensees to resolve. For example:

1) The specification of at least a three-meter earth cover is unnecessarily strict, extremely expensive, and unsupported by the record. Depth of cover necessary to achieve the specified limitations on radon exhalation varies with the permeability and moisture content of soils available for use as cover. Frequently two meters of cover or less will adequately reduce radon exhalation. Moreover, the additional footage cannot be justified as a hedge against erosion in light of the rock cover, slope and contour requirements of Criterion 4, which specifically addresses the question of erosion. Criterion 6 should be amended to delete any minimum cover requirements.

2) The preclusion of reliance on synthetic layers to reduce radon

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exhalation should be deleted, and use of such technology (as it presently exists or may later be developed) should be accepted upon demonstration of its effectiveness and promise for long-term integrity.

D. The statement in Criterion 6 that "direct gamma exposure from the tailings or wastes should be reduced to background levels" (emphasis added) is unclear. The provision should be amended to reflect the Department's precise intent with respect to control of gamma exposure.

E. Criterion 6 seems to envision use of "non-soiled (sic) materials" as a means of reducing "tailings covers to less than three meters." This appears to conflict with the immediately preceding sentence indicating that the "effects of any thin synthetic layer shall not be taken into account in determining the calculated radon exhalation level." These two sentences should be made consistent by eliminating the rejection of the use of synthetic materials and simply requiring (as the second sentence presently does) that the efficiency and probable long-term stability of such materials be demonstrated if they are "proposed to reduce tailings cover to less than three meters."

F. Criterion 6 provides that "near surface cover materials (i.e., within the top three meters) shall not include mine waste or rock that contains elevated levels of radium..." This provision is vague and ambiguous. It is not clear whether it bars all use of mine waste or only mine waste with elevated levels of radium. If it means the former, it is arbitrary and overbroad. It is unclear what the Department means by the expression "elevated levels of radium".

Appendix 6-1 - Risk From Various Levels of Radon Flux Control

It was stated in the draft GEIS analysis that the greatest risk to the general public from uranium milling is from radon emanation from the mill tailings after final disposal. In the analysis of this problem presented in the draft GEIS, projected Continental health effect expressed as total health effects over 100, 1000, and 100,000 year periods were examined at a series of different depths of cover. It is clear from the does committments in Table 6.39, page 6-72, that there are very substantial differences in the level of risk for the population of the Regions and for those living in the remainder of the Continent. The use of total numbers for health effects also makes it difficult to compare the rates of risk experienced with other risks commonly encountered in the workplace and by the general public.

The costs of cover for the tailings used in this GEIS analysis were estimated on the basis of a hypothetical combined voer consisting of three specific soil types. The soil cover assumed by the NRC consists of one-third Soil A, one-third Soil B, and one-third a combination of 0.6 meters of clay plus the remainder Soil A. This makes it difficult to ascertain the effects of real situations where only certain soils will be available. Also, only average costs per health effect averted were provided. This is misleading because the cost of cover is directly proportional to the depth used while the corresponding health effects decrease in an exponential manner. The first foot added is more effective than the second, etc. In this situation the critical variable is not the overall average cost per health effect averted but what does an incremental additional expenditure provide in terms of the incremental number of estimated health effects which it averts.

In order to provide a more comprehensive basis for a properly informed societal decision, the CMA, using infomration compiled by the American Mining Congress, has presented an analysis, based entirely on the risk and cost data provided in the GEIS, in the following manner:

1. Regional and Far Field[1] risks are shown separately. Results are expressed as deaths per million people exposed per year so that the level of absolute risk can be compared to other risks.

2. Costs for various levels of cover have been calculated separately for all three soil options, i.e. Soil A, Soil B, and 0.6 meters of clay plus Soil A. These costs have been used to find the incremental cost per incremental health effect averted for various levels of control. The results are compared to the costs to avert other risks described in the previous section.

For clarity, the discussion fo risk comparisons will be given in Appendix 6-1. The cost-effectiveness results will be treated in Appendix 6-2.

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(1) Far-field is defined as Continental minus Region. See GEIS 6.4 and 6.4.1, page 6-64.

Estimation of Risks

GEIS Basis

Table 12.5, page 12-18, of the GEIS presents a series of cumulative costs and cumulative health effects based on the persistent total Continental environmental dose committments given in Table 6.39. To develop this table the Continental dose commitment was combined with the health effect factors from Appendix G, Table G-7.1 to obtain the persistent annual Continental health effects for the base case flux of 450 pCi/m^2-sec. The health effects at other flux levels were obtained by ratio.

Table 6.39 also shows the component Regional and U.S. Non-Regional, Mexico, and Canada (hereinafter referred to as Far-Field) dose commitments that made up the total Continental doses. The same calculation procedure used by the staff has been applied to the component doses to develop a complete picture of Regional, Far-Field, and Continental effects. Both cumulative and incremental health effects for each successive reduction in flux are shown for all levels of control. The Near-Field and Continental populations of 517,000 and 460 x 10^6, respectively, have been used to express the cumulative risks as a rate in terms of deaths/million/year.

A "background risk factor" (BRF) for each flux rate has also been calculated as the ratio of the appropriate risk from natural background radiation sources to the risk from radon emination from the tailings. A BRF of a thousand means that the risk from background radiation is a thousand times larger than the calculated risk from uranium milling.

The various factors calculated are summarized in Table A6-1. It is fully recognized that the accuracy of all of the calculated values is substantially less than the number of significant figures shown in the table. It is necessary, however, to retain such figures to be able to show trends and to make relative comparisons.

AMC Basis

It was repeatedly stated in the GEIS that every effort was made to present a conservative picture. As an example, Section 5.3.2, page 5-7 states:

> "These released present what the staff considers to be the upper bound of "worst case" situation for the model mill." (Emphasis added)

The "worst case" situation for the model mill was then multiplied by the 82 model mills to obtain the values for the overall impacts.

This dedication to conservatisim has two implicit assumptions of very dubious validity. First, there are a substantial number of factors which make up the dose commitment and risk factor estimates that yield the final value of calculated health effects. It is highly improbable that "worst case" conditions will occur simultaneously for all factors or even for a majority of them at any particular mill.

Second, it is assumed that not only do all of the worst cases occur simultaneously at any particular mill but also that they all occur all of the time at all of the mills. This is a pyramiding of safety factors beyond reasonable conservation and makes it difficult to assess the meaning of the end result.

TABLE A6-1

PERSISTENT SOMATIC HEALTH EFFECTS OF VARIOUS RADON ATTENUATION LEVELS

Flux Limit	REGIONAL(1)(4)				FAR FIELD(2)(5)				CONTINENTAL(3)			
	Est. Health Effect		Risk(6)	(7)(8)	Est. Health Effect		Risk(6)	(7)(8)	Est. Health Effect		Risk(6)	(7)(8)
(pCi/m²-sec.)	Cumulative	Incremental	(d/M/y)	BRF	Cumulative	Incremental	(d/M/y)	BRF	Cumulative	Incremental	(d/M/y)	BRF
450	2.10	0	4.06	18.2	7.60	0	0.0165	1,515	9.70	0	0.0211	1,184
100	0.46	1.64	0.89	83.1	1.67	5.93	0.0036	6,944	2.13	7.57	0.0046	5,435
50	0.23	0.23	0.45	164	0.84	0.83	0.0018	13,890	1.07	1.06	0.0023	10,870
10	0.046	0.184	0.089	831	0.167	0.67	0.00036	64,440	0.213	0.86	0.00046	54,350
5	0.023	0.023	0.045	1644	0.084	0.083	0.00018	139,000	0.117	0.106	0.00023	108,700
3	0.0139	0.091	0.027	2740	0.0501	0.0339	0.00010	250,000	0.064	0.043	0.00014	178,600
2	0.0091	0.0048	0.018	4111	0.0329	0.0172	0.00007	357,000	0.042	0.022	0.00009	278,000
1	0.0045	0.0046	0.0087	8505	0.0165	0.0164	0.00004	625,000	0.021	0.021	0.00005	500,000

(1) Includes regions encompassing 82.2 mills. Total population assumed constant at [(82.2 mills)/(12 mills/region)] (75,500 people/region) = 517,000.

(2) Far Field is made up of U.S. Non-Regional, Canada, and Mexico. Total population assumed constant at 460×10^6.

(3) Continental effects are the sum of Regional plus Far Field effects.

(4) Health effects calculated by ratio of 2.1/9.7 applied to the Continental effects.

(5) Health effects calculated by a ratio of 7.6/9.7 applied to Continental effects.

(6) Risks calculated as cumulated somatic health effects divided by the population at risk. Expressed as deaths/million/year.

(7) This factor compares the risk from natural background radiation sources to the risk from uranium milling, i.e. the factor equals $\frac{\text{Risk from Background}}{\text{Risk from Milling}}$. A factor of 1000 means the background risk is 1000 times larger than the risk from milling.

(8) Background calculated risks as follows:

Near field (Regional): Whole body 0.143 rem, bone 0.250 rem, lung 0.704 rem which gives an annual risk of 7.4×10^{-5} or 74 death/M/y (Table 6.28, page 6-52).

Far Field and Continental: Whole body 0.080 rem, bone, 0.172 rem, lung 0.161 rem for an annual risk of 2.48×10^{-5} or 25 d/M/y (Tabl. 6.37, page 6-71). Factors given in Table G-7.1 used to convert dose to risk.

A. General Note:

It is fully recognized that the accuracy of all of the calculated values is far less than the number of significant figures shown in the table. It is necessary to retain the figures to show trends.

In order to put the risk assessment in a more reasonable perspective, three areas in the GEIS need to be adjusted:

1. The number of model mills required.

2. The radon flux from the uncovered tailings from the base case model mill.

3 The estimates of population risk.

The cumulative impacts in the GEIS are based on a projected nuclear generating capacity of 380 GW_e and an enrichment tail of 0.25%. A recent DOE publication[1] gives a mid-case value of 255 GW_e in the year 2000 and an enrichment tail of 0.2%. On a national basis, this requirement could be met by 50 model mills vs the 82 in the GEIS, assuming 6000 MT from unconventional sources. The CMA believes that this is a more realistic and therefore more appropriate value to use in the estimation of environmental impacts.

The adjustment from 82 to 50 mills could be made by keeping the 12 mill per region configuration and reducing the total number of regions or by keeping the number of regions constant and reducing the density of mills per region. The 12 mill per region assumption is considered to be substantially too high and if fewer mills are required, there will be less tendency for them to be concentrated in large numbers in any particular small area. The option of keeping the number of regions constant and reducing the mills per region has been selected. This results in a reduction in persistant health effects in both the Regional and Far-field operations by a factor of 50/82.

The base case estimates assume a radon exhalation rate of 450 pCi/m^2-sec. for the uncovered tailings at the model mill. In contrast to this Appendix P, page P-2, in the GEIS, calculates uncovered tailings flux for 450 pCi Ra-226/g to be 209 pCi/m^2-sec. An ANL paper (Momeni, et al) given in February 1979 at a Health Physics Society Symposium presents experimentally measured flux rates of 0.64 and 0.30 pCi Rn/m^2-sec. per pCi Ra-226/g for acid and carbonate leached tailings respectively. The former value (acid leaching) would give 288 pCi/m^2-sec. for bare tailings.

A base case value of 250 pCi/m^2-sec. is a more realistic overall average flux level for environmental impact analysis. Since radon is the principal source of Regional and Far-feild persistant radiological impacts, a factor of 250/450 has been applied to the GEIS values to adjust to a more realistic value.

The extent to which health effects are overestimated is a complex question that has been discussed in detail in the literature, and relevant observations pertaining to these overestimations are summarized below. Both the estimation of dose committment and the estimate of the resulting health effects must be considered. Impact Associates[2] has shown that certain dose commitments

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(1) John Kleminic, D.O.E., October 1978.

(2) Impact Associates, written and direct testimony, NRC Hearing on NUREG 0511, Albuquerque, New Mexico, October 18, 1979.

may be overestimated by factors ranging from 4 to 40. Dr. Schaiger [2] has suggested a factor of 40-100 overestimation of the health effects due to radon. Mr. Swent [3] has examined a number of factors not generally covered by the other testimony and estimates that these lead to an overestimation by a factor of about 6.

On the basis of their information it appears that persistent health effects have been overestimated in the GEIS by at least a factor of ten. This factor will be used in this analysis. Note that this factor still includes linear, non-threshhold extrapolation to obtain risk estimates at low exposure levels.

The combination of these measures of conservativeness yields a factor that can be applied to the earlier risk calculations based on the GEIS figures to provide a more realistic estimate of risk. Thus:

Factor = (No. of Mills) (Radon Flux) (Health Effect Factor)

$$\text{Factor} = \frac{50}{82}\ \frac{250}{450}\ \frac{1}{10} = 0.034$$

This factor can be applied directly to the risks shown previously in Table IX to adjust for more realistic but still conservative conditions. It should be noted, however, that since a part of the basis for the reduction in risk is a change in the radon flux from uncovered piles from 450 to 250 pCi/m^2-sec. a corresponding adjustment must be made in the related flux to put the two estimates on a directly comparable basis.

These adjustments of risk and corresponding flux level have been made in the Regional values from Table A6-1 and the results are summarized in Table A6-2. Only the Regional results have been calculated since it is evident from Table A6-1 that they are higher than those for the Far-field by a factor of about 250 and are thus the most critical.

Comparison of Risks

Annual rates of risk for the Regional, Far-field and Continental populations based on the GEIS values (Table A6-1) are shown as a function of radon flux in Figure A6-1. The regional values from the CMA assumptions (Table A6-2) are also given. A variety of occupational and general public risks developed previously are also shown for comparison. Where a range of risk occurs in the comparative information, the mid-range value is indicated and the range is listed. Note that these risks are not related to any particular radon flux and are presented in an orderly fashion in the open portion of the figure.

It should also be noted that the wide range of risks to be included made it necessary to use a logarithmic scale on the vertical axis. This makes it more idfficult to visualize the true differences and it should be emphasized that each major division represents a change of a factor of 10, i.e., an order of magnitude.

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(2) K. Schaiger, written and direct testimony, NRC Hearing on NUREG 0511, Albuquerque, New Mexico, October 18, 1979.

(3) L. Swent, written and direct testimony, NRC Hearing on NUREG 0511, Albuquerque, New Mexico, October 18, 1979.

TABLE A6-2

PERSISTENT REGIONAL SOMATIC HEALTH EFFECTS AT VARIOUS RADON ATTENUATION LEVELS

	BASE CASE(2)					REALISTIC ESTIMATE			
Flux Limit (pCi/m^2-sec.)	Estimated Health Effects Cumulative	Estimated Health Effects Incremental	Risk(4) (d/M/y)	(5)(6) BRF	Adjusted(3) Flux Limit (pCi/m^2-sec.)	Estimated Health Effects Cumulative	Estimated Health Effects Incremental	Risk(4) (d/M/y)	(5)(6) BRF
450	2.10	0	4.06	18.2	250	0.071	0	0.14	530
100	0.46	1.64	0.89	83.1	56	0.016	0.055	0.031	2,400
50	0.23	0.23	0.45	164.0	28	0.008	0.008	0.015	4,600
10	0.046	0.184	0.089	831.0	5.6	0.0016	0.0064	0.0031	24,000
5	0.023	0.023	0.045	1,644.0	2.8	0.0008	0.0008	0.0015	49,000
3	0.0139	0.091	0.027	2,740.0	1.7	0.0005	0.0003	0.0010	74,000
2	0.0091	0.0048	0.018	4,111.0	1.1	0.0003	0.0002	0.0006	123,000
1	0.0045	0.0046	0.0087	8,505.0	0.6	0.00015	0.00015	0.0003	246,000

(1) Includes the same regions encompassing either 82.2 or 50 mills. Total population assumed constant at (82.2 mills)/(12 mills/region) (75,500 people/region) = 517,000.

(2) Base Case figures from Table 9.

(3) Number of mills adjusted 50/82.2; flux adjusted 250/450; dose-risk factor adjusted 1/10.

(4) Risks calculated as cumulated somatic health effects divided by the population at risk. Expressed as dealths/million/year.

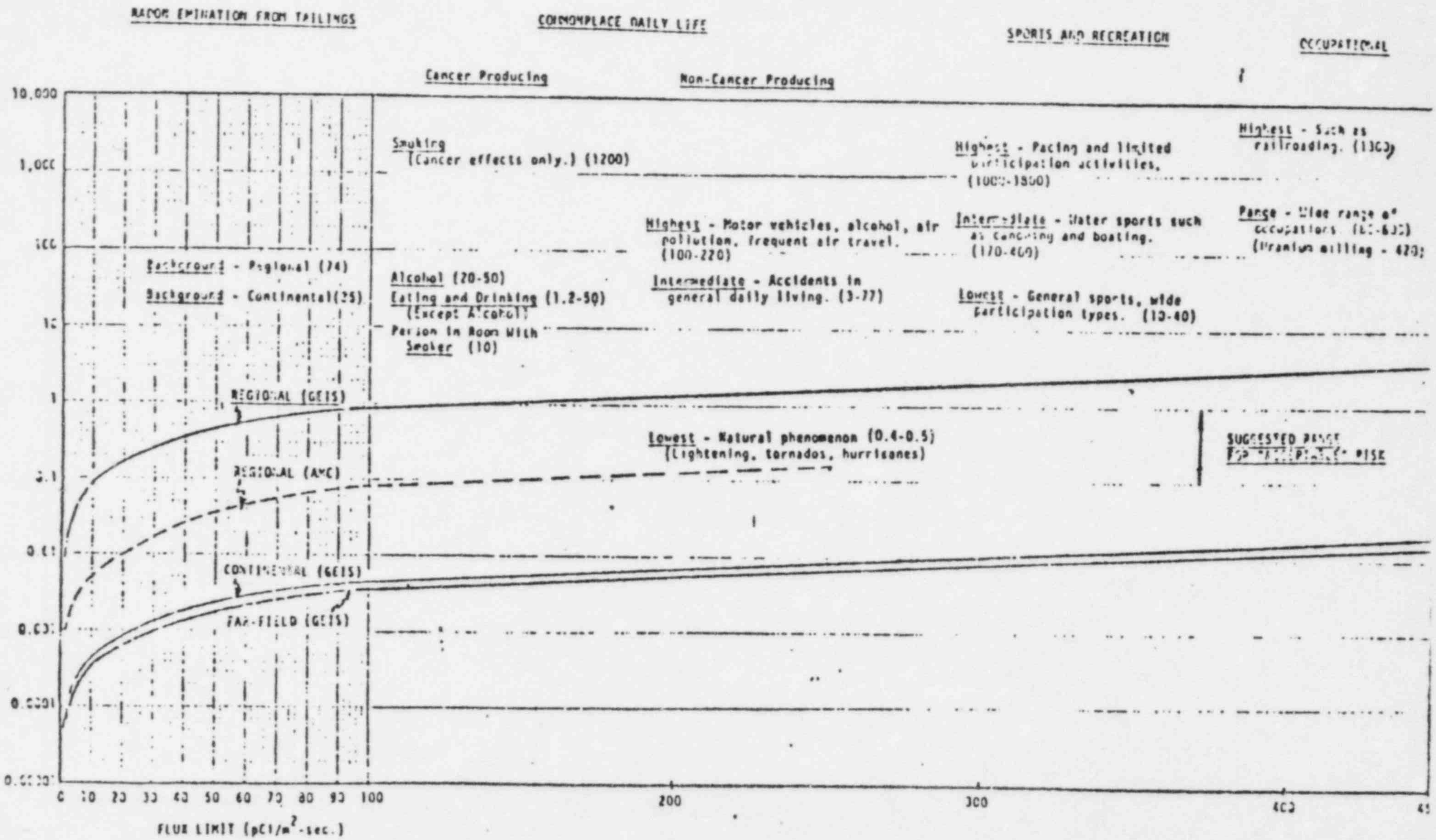
(5) This factor compares the risk from natural background radiation sources to the risk from uranium milling, i.e. the factor equals $\frac{\text{Risk from Background}}{\text{Risk from Milling}}$.

(6) Background risks as follows: Near-Field (Regional): Whole body 0.143 rem, bone 0.250 rem, lung 0.704 rem which gives an annual risk of 7.4×10^{-5} or 74 death/M/y (Table 6.28, page 6-52).

RISK COMPARISON

REGIONAL AND CONTINENTAL EXPOSURES

OCCUPATIONAL AND DAILY LIVING



Consider first the risks taken directly from the draft GEIS. The Far-field and Continental risks shown by the bottom two curves are lower than those for the Regional population by a factor of about 200 and 250, respectively.

On a Far-field basis the risk from uncovered tailings is nearly an order of magnitude below the lower end of the suggested acceptable range and is about the same as the FDA recommendation of an acceptable level for carcinogenic residues in meat products. It is hard to see how any cover is justified on a technical basis due to risks to the Far-field or Continental population.

The Regional risks (GEIS) are shown by the upper curve in the figure. At the base case level of no control, i.e., a flux of 450 pCi/m^2-sec, the risk is about 4 d/M/y. This is about 20 times smaller than that from natural background radiation, about three times smaller than being in a room with a smoker or common household accidents and is about ten times greater than being struck by lightning. It is, however, above the suggested acceptable range of 0.1-1 d/M/y and indicates that, if the GEIS estimates are correct, some amount of cover to lower radon flux to the 10-100 pCi/m^2-sec. range is appropriate, based on risks to the Regional population. The 2 pCi/m^2-sec. requirement suggested by the GEIS, and proposed by the Department, is clearly not supported by the risks.

Consider next the Regional risks based on the CMA realistic adjustments. The risk from uncovered tailings is at the low end of the range suggested so that the technical basis for cover is very marginal. At a flux of 25 pCi/m^2-sec. the risk matches the FDA suggestion for food residues. The 2 pCi/m^2-sec. suggestion obviously has even less support than given by the GEIS values.

Although the various general population risks are shown in the figure, a useful perspective can be gained by examining the specific numerical ratios shown in the following table. These risks have been selcted as representative of involuntary risks which are acceptable to the population in general. Although there have been some limited moves to reduce involuntary exposure to smoking and to reduce home accidents, northing approaching expenditures of the hundreds of millions of dollars that would be needed to achieve a major reduction. Nothing has been seriously advanced to lower the substantially greater hazards due to radiation exposure during air travel. There has been no move to warn against nor limit travel to parts of the country receiving high background radiation nor any recommendation that people should not live in those parts of the country.

For the GEIS figures where conservative assumptions are repeatedly compounded, the Regional risk from uncovered tailings is about ten times greater than being struck by lightning, about the same as a single airplane trip, three times smaller than being in the room with a smoker and common home accidents, twenty times smaller than natural background radiation, and thrity times smaller than frequent air travel. With the more realistic but still conservative

CMA values the same risks range from half that from lightning to 1 to 3 orders of magniturde less than the other risks listed. These risks apply only to the 500,000 people that are predicted to be living in the regions around the mill. The risks to the remaining population would be less by a further factor of about 200.

At a flux of 50 pCi/m^2-sec. the GEIS-based Regional risks range from about the same as being struck by lightning to 10 to 200 times less than the other risks cited. The corresponding CMA values range from 10 to 2300 times smaller than the risk from the tailings, i.e., one to more than three orders of magnitude. There is clearly no reason to require flux limits as low as 50 pCi/m^2-sec. based on population risks. At the 2 pCi/m^2-sec. level recommended, the GEIS risks range from 30 to 6400 times smaller than the common general public risks and the AMC values from 100 to 23,000 times smaller. Even the GEIS values do not support the need to acheive these levels.

Conclusions

The comparison of the absolute risks from uranium milling to other risks experienced and found acceptable to society shows that, on an overall Continental basis, using even the grossly conservative values in the GEIS, there is little technical justification for any cover on the tailings piles.

Examination of the Regional risks based on the GEIS values shows that a maximum flux in the range of 10-100 pCi/m^2-sec. is a reasonable guideline. The more realistic, but still conservative, CMA estimates suggest that there is no strong technical reason to require flux levels below 100 pCi/m^2-sec. The value of 2 pCi/m^2-sec. recommended in the GEIS is totally without support.

Appendix 6-2 - Cost Effectiveness of Various Levels of Radon Flux Control

Introduction

It was pointed out in Appendix 6-1 that the draft GEIS analysis of cost-effectiveness was difficult to use as a basis for informed decisions because a hypothetical combined cover was used and only average rathern than incremental costs and health effects were provided. In this Appendix a more detailed analysis will be provided using costs recommended in the GEIS and considered representative by the CMA. It should be noted that cost-effectiveness should consider all of the health effects involved so Continental figures are used in this analysis.

Estimation of Incremental Costs Per Incremental Health Effect Averted

The GEIS presented a flux control cost comparison in terms of a combined cover of an average composition. It is more useful to examine the components individually. Total and incremental industry costs for each successive level of flux control using the cost figures given in the GEIS have been calculated for Soil A, Soil B., clay and a combination of 0.6 m clay plus Soil A and are listed in Table A6-3. The corresponding cover needed to attain various flux levels for each type of material is also included and the results are shown in Figure A6-2. The figure is basically a more complete version of Figure 9.1, page 9-25 of the GEIS except that total thickness, not just that of the soil cover over the clay is given.

In testimony pertaining to the GEIS, the AMC presented evidence that the average overall industry costs have been substantially underestimated in the GEIS. A factor of two has been selected as a conservative representation of the degree of underestimation for use in this analysis. Total and incremental cover costs have been calculated using this factor applied to the GEIS costs in the same manner just described. Results are summarized in Table A6-4.

The GEIS values of incremental cover costs to achieve each increment in flux reduction from Table A6-3 have been combined with the corresponding GEIS incremental health effects from Table A6-1 to give the incremental cost per health effect averted shown in Table A6-5. Integration periods of one hundred and a thousand years have been included. The results of similar calculations based on adjusted Continental health effects and the adjusted incremental cover costs from Table A6-4[1] are summarized in Table A6-6.

Comparisons of Cost-Effectiveness

The results for the 100 year integration period based on the GEIS values are shown as a function of flux limit in Figure A6-3 using rectangular coordinates. As would be expected, the more effective the cover, the lower the level it is reasonable to reach. It is also evident that costs begin to escalate rapidly in the 5 to 20 pCi/m^2-sec. range depending on the quality

(1) At a flux of 250 pCi/m^2-sec. the Continental health effects are

$$\frac{250}{450}\ \frac{50}{82}\ \frac{1}{10}\ (9.7) = 0.33/\text{year}$$

Effects at other flux levels obtained by ratio.

TABLE A6-3

VARIOUS COVER REQUIREMENTS FOR RADON FLUX ATTENUATION

Limit (m^2-sec.)	Soil A: Depth(1) Req'd. (m)	Soil A: Total(2) Ind. Cost(4) ($MM)	Soil A: Incremental Ind. Cost(4) ($MM)	Soil B: Depth(1) Req'd. (m)	Soil B: Total(2) Ind. Cost(4) ($MM)	Soil B: Incremental Ind. Cost(4) ($MM)	Clay: Depth(1) Req'd. (m)	Clay: Total(2) Ind. Cost(4) ($MM)	Clay: Incremental Ind. Cost(4) ($MM)	0.6m Clay + Soil A: Depth(1) Req'd. (m)	0.6m Clay + Soil A: Total(2) Ind. Cost(4) ($MM)	0.6m Clay + Soil A: Incremental Ind. Cost ($MM)
50	0	0	-	0	0	-	0	0	-	0	0	-
00	1.14	98	98	2.32	199	199	0.27	23	23	-	-	-
50	1.66	142	44	3.31	290	91	0.39	33	10	-	-	-
10	2.88	246	104	5.87	502	212	0.68	58	25	0.92(3)	79	79
5	3.40	291	45	6.94	593	91	0.80	68	10	1.45	124	45
3	3.79	324	33	7.73	661	68	0.89	76	8	1.83	157	33
2	4.09	350	26	8.36	715	54	0.96	82	6	2.13	174	17
1	4.62	395	45	9.42	805	90	1.08	92	10	2.66	227	53

(1) Calculated from Equation 1 on page 9-24 and permeability factors from Figure 9.1, page 9-25. (GEIS)

(2) Total industry cost. Assumes 82.2 mills at 800,000 meters^2 per mill and a cost of $1.30 per cubic meter for cover.

(3) Flux of 15.3 pCi/m^2-sec. emerging from 0.6 meters of clay used as J_0 in flux equation of note 1 above for this case. The first cost figures shown are for the 0.6 meters clay and 0.32 meters soil A needed to reach a flux of 10 pCi/m^2-sec.

(4) Ind. Cost = Industry Cost.

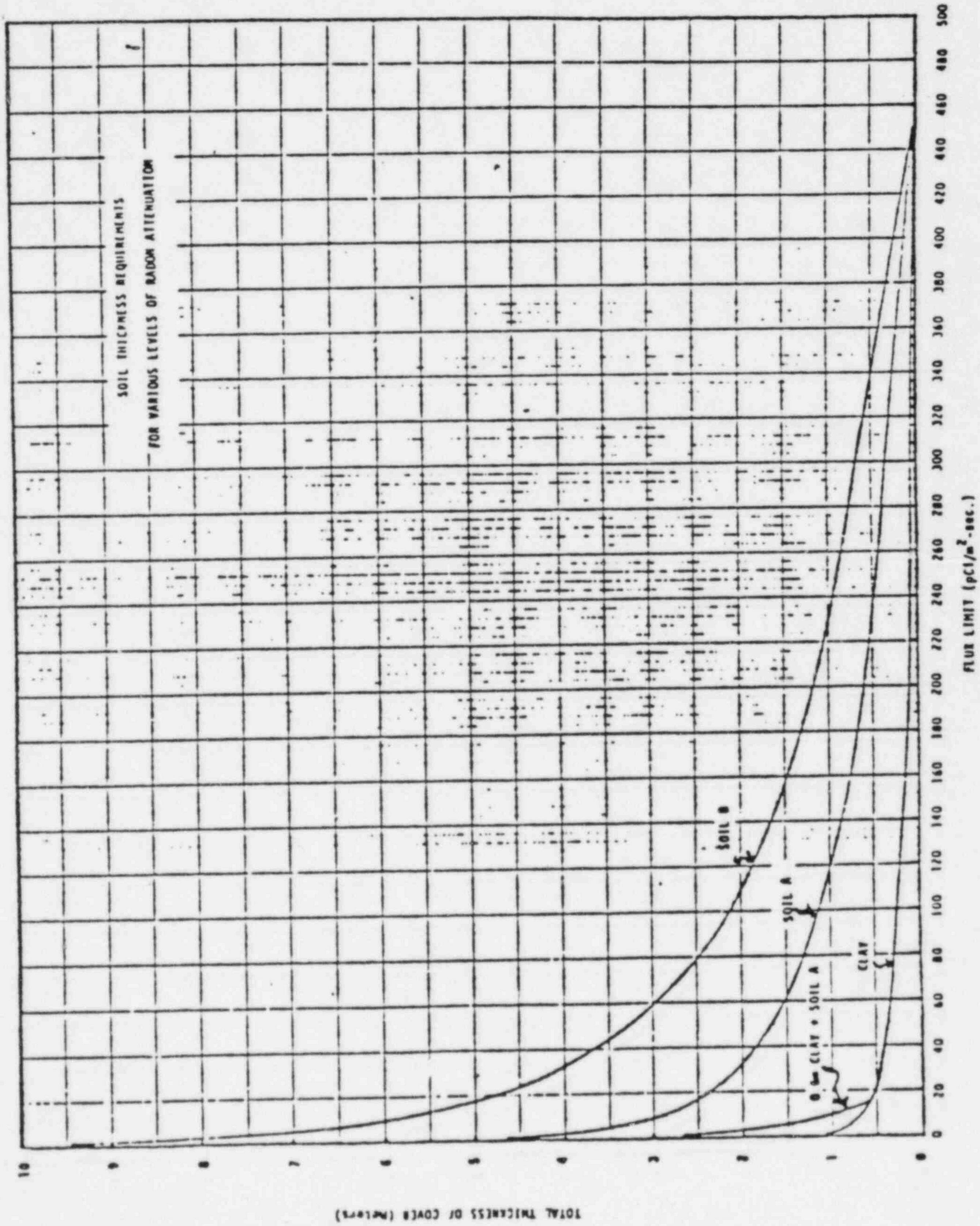

SOIL THICKNESS REQUIREMENTS
FOR VARIOUS LEVELS OF RADON ATTENUATION
SOIL B
SOIL A
CLAY
CLAY + SOIL A
FLUX LIMIT (pCi/m²-sec.)
TOTAL THICKNESS OF COVER (Meters)

TABLE A6-4

REALISTIC ASSUMPTION -
VARIOUS COVER REQUIREMENTS FOR RADON FLUX ATTENUATION

ux Limit	Soil A			Soil B			Clay			0.6m Clay + Soil A		
1/m²-sec.)	Depth[1] Req'd. (m)	Total[2] Ind. Cost[4] ($MM)	Incremental Ind. Cost[4] ($MM)	Depth[1] Req'd. (m)	Total[2] Ind. Cost[4] ($MM)	Incremental Ind. Cost[4] ($MM)	Depth[1] Req'd. (m)	Total[2] Ind. Cost(4) ($MM)	Incremental Ind. Cost(4) ($MM)	Depth[1] Req'd. (m)	Total[2] Ind. Cost[4] ($MM)	Increment Ind. Cos ($MM)
250	0	0	-	0	0	-	0	0	-	0	0	-
100	0.69	72	72	1.41	147	147	0.16	17	17	-	-	-
50	1.22	127	55	2.48	258	111	0.29	30	13	-	-	-
30	1.60	166	39	3.27	340	82	0.38	40	10	-	-	-
10	2.43	253	86	4.97	517	177	0.57	59	19	-	-	-
5	2.96	308	55	6.04	628	111	0.69	72	13	1.00[5]	104	104
3	3.34	347	39	6.82	709	81	0.78	81	9	1.39	145	41
2	3.65	380	33	7.45	775	66	0.86	89	8	1.09	176	31
1	4.17	434	54	8.59	893	119	0.98	102	13	2.21	230	54

(1) Calculated from Equation 1 on page 9-24 and permeability factors from Figure 9.1, page 9-25. (GEIS)

(2) Total industry cost. Assumes 50 mills at 800,000 meters² per mill and a cost of $2.60 per cubic meter for cover.

(3) Flux of 8.5 pCi/m²-sec. emerging from 0.6 meters of clay used as J_0 in flux equation of note 1 above for this case. The first cost figures shown are for the 0.6 meters clay and 0.4 meters soil A needed to reach a flux of 5 pCi/m²-sec.

(4) Ind. Cost = Industry cost in millions of dollars.

(5) 8.5 pCi/m²-sec. = 0.6 meters of clay at a total and incremental cost of $62.4 MM.

of the cover available. A 2 pCi/m^2-sec. level is far into the region of diminishing cost effectiveness for all types of cover with costs in the range of 8-25 million dollars per health effect averted. Since the curves for the other integration periods will have the same relative shapes, they lead to the same basic conclusion, i.e. 2 pCi/m^2-sec. is well into the range where cost effectiveness is poor.

With the CMA adjusted values (Table A6-6) the incremental cost per health effect values move up rapidly for all levels of flux examined. A marked change in slope is indicated at approximately 80 pCi/m^2-sec. for Soil A and would occur at some point greater than a flux of 100 pCi/m^2-sec. for Soil B.

The GEIS proposes to specify both a maximum flux limit of 2 pCi/m^2-sec. and a minimum depth of cover of 3 meters. The interrelationship between these two variables and cost-effectiveness is shown in Figure A6-4 for the values based on the GEIS. The ordiante is the incremental cost per health effect averted (log scale) and the abcissa is the total depth of cover in meters. A solid line is given for each of the three types of cover with the numbers by each point showing the corresponding flux limit in pCi/m^2-sec. The scatter from the linear relationship depicted appears to be largely the effect of rounding. The suggested range of appropriate societal costs of $250,000-$500,000 developed previously is also shown for reference.

For the most effective cover, clay plus Soil A, the 0.6m. of clay specified reduces the flux to about 15 pCi/m^2-sec. and averts nearly 9.5 health effects per year. This leaves only about 0.2 health effects per year for the additional cover to impact upon. Further incremental reductions are thus very small so the incremental cost per health effect curve rises rapidly. For the less efficent covers, Soil A and Soil B, the health effects averted are spread over a wider range of cover depths so the curves increase less rapidly.

Using these values from the GEIS it is evident from the figure that the radon flux level that can be attained at the suggested range of societal costs is strongly dependent on the type of cover available. For the clay plus Soil A a range of 4-7 pCi/m^2-sec. occurs at a total cover of about 1-1/4 meters; for Soil A alone the range is 40-60 pCi/m^2-sec. at a depth of 1-1/2 - 2 meters; and for Soil B only 60-100 pCi/m^2-sec. can be reached at a cover depth of 2-3 meters.

If the acceptable cost to society is increased to $1,000,000 per health effect, the attainable levels for the three cover alternatives are 4, 20 and 40 pCi/m^2-sec. at depths of 1-1/2, 2-1/2, and 4 meters, respectively. To reach the level of 2 pCi/m^2-sec. recommended by the staff, costs would range from 8 to 24 million dollars per health effect averted, at depths of 2, 4, and 8 meters, respectively (Clay + A, A, B). Even a 1000 year integration period would only reduce the range to 800 thousand to 2.4 million dollars per health effect.

The corresponding values based on the CMA adjustments are shown in Figure A6-5. Since the number of health effects to be averted are considerably lower than the GEIS values and the costs are double, the cost per health effect shifts up sharply from the levels shown in the previous figure. All of the results are an order of magnitude or more above the suggested range of appropriate societal costs.

On the CMA basis, if clay is available, a flux of 5 pCi/m^2-sec. may be approached but only at a cost per health effect around 3 million dollars. If clay is not available, it will be difficult and not cost-effective to reach flux limits below 100 pCi/m^2-sec. Values for 2 pCi/m^2-sec. are off-scale and range from 220 to 470 million dollars per health effect averted. One thousand year integration reduces these to 22-47 million dollars.

Conclusions

The GEIS estimates shown in Figure A6-4 demonstrate, and the CMA estimates in Figure A6-5 emphasize that large expenditures of societal resources to reduce radon flux from tailings piles to very low levels is neither cost-effective nor reasonable. There are many more effective ways to reduce societal risks. These results also show that the inflexible level of 2 pCi/m^2-sec. suggested by the GEIS is grossly inappropriate. The need for a flexible range, on the order of 10-100 pCi/m^2-sec., with strong consideration of site-specific conditions is clearly demonstrated.

TABLE A6-5

INCREMENTAL COST PER HEALTH EFFECT AVERTED[1] BY RADON FLUX ATTENUATION

Flux Limit (pCi/m^2-sec.)	Depth of Cover (Meters)	Annual[2] Incremental Health Effects Averted (per year)	Soil A: Incremental[3] Cost ($MM)	Soil A: 100 Year Integration ($/Health Effect)	Soil A: 1000 Year Integration ($/Health Effect)
100	1.14	7.57	98	129,000	12,900
50	1.66	1.06	44	415,100	41,510
10	2.88	0.86	104	1,209,000	120,900
5	3.40	0.106	45	4,245,000	424,500
3	3.79	0.043	33	5,200,000	520,000
2	4.09	0.022	26	11,820,000	1,182,000
1	4.62	0.021	45	21,420,000	2,142,000

Flux Limit (pCi/m^2-sec.)	Depth of Cover (Meters)	Annual[2] Incremental Health Effects Averted (per year)	Soil B: Incremental[3] Cost ($MM)	Soil B: 100 Year Integration ($/Health Effect)	Soil B: 1000 Year Integration ($/Health Effect)
100	2.32	7.57	199	261,800	26,180
50	3.31	1.06	91	858,500	85,850
10	5.87	0.86	212	2,465,000	246,500
5	6.94	0.106	91	8,585,000	858,500
3	7.73	0.043	68	10,600,000	1,600,000
2	8.36	0.022	54	24,550,000	2,455,000
1	9.42	0.021	90	42,860,000	4,286,000

Flux Limit (pCi/m^2-sec.)	Depth of Cover (Meters)	Annual[2] Incremental Health Effects Averted (per year)	0.6 Meters Clay + Soil A: Incremental[3] Cost ($MM)	0.6 Meters Clay + Soil A: 100 Year Integration ($/Health Effect)	0.6 Meters Clay + Soil A: 1000 Year Integration ($/Health Effect)
100	-	7.57	-	-	-
50	-	1.06	-	-	-
10	0.92	0.86 (9.5)[4]	79	83,000	8,300
5	1.45	0.106	45	424,500	42,450
3	1.83	0.043	33	5,200,000	520,000
2	2.13	0.022	17	7,773,000	777,300
1	2.66	0.021	53	25,240,000	2,524,000

Somatic effects, Continental basis.

Annual values from Table IX.

rom Table XI.

.6 meters of clay reduces the calculated flux to 15.3 pCi/m^2-sec. The cost shown includes an additional 0.3 meters of soil A and the total incremental health effects averted to the 10 pCi/m^2-sec. of 9.5/year.

REALISTIC ASSUMPTION - INCREMENTAL COST PER HEALTH EFFECT AVERTED(1) BY RADON FLUX ATTENUATION

Flux Limit (pCi/m^2-sec.)	Depth of Cover (Meters)	Annual(2) Incremental Health Effects Averted (per year)	Soil A: Incremental(3) Cost ($MM)	Soil A: 100 Year Integration ($/Health Effect)	Soil A: 1000 Year Integration ($/Health Effect)
250→100	0.69	0.198	72	3,640,000	364,000
50	1.22	0.066	55	8,300,000	830,000
30	1.60	0.026	39	15,000,000	1,500,000
10	2.43	0.027	86	31,900,000	3,190,000
5	2.96	0.0066	55	83,000,000	8,300,000
3	3.34	0.0026	39	150,000,000	15,000,000
2	3.65	0.0014	33	236,000,000	23,600,000
1	4.17	0.0013	54	415,000,000	41,500,000

Flux Limit (pCi/m^2-sec.)	Depth of Cover (Meters)	Annual(2) Incremental Health Effects Averted (per year)	Soil B: Incremental(3) Cost ($MM)	Soil B: 100 Year Integration ($/Health Effect)	Soil B: 1000 Year Integration ($/Health Effect)
250→100	1.41	0.198	147	7,400,000	740,000
50	2.48	0.066	111	16,800,000	1,680,000
30	3.27	0.026	82	31,500,000	3,150,000
10	4.97	0.027	177	66,000,000	6,600,000
5	6.04	0.0066	111	168,000,000	16,800,000
3	6.82	0.0026	81	311,000,000	31,100,000
2	7.45	0.0014	66	471,000,000	47,100,000
1	8.59	0.0013	119	915,000,000	91,500,000

Flux Limit (pCi/m^2-sec.)	Depth of Cover (Meters)	Annual(2) Incremental Health Effects Averted (per year)	0.6 Meters Clay + Soil A: Incremental(3) Cost ($MM)	0.6 Meters Clay + Soil A: 100 Year Integration ($/Health Effect)	0.6 Meters Clay + Soil A: 1000 Year Integration ($/Health Effect)
250→100	-	0.198	-	-	-
50	-	0.060	-	-	-
30	-	0.026	-	-	-
10	-	0.027	-	-	-
5	1.00	0.0066 (0.32)	104	3,250,000	325,000
3	1.39	0.0026	41	158,000,000	15,800,000
2	1.69	0.0014	31	221,000,000	22,100,000
1	2.21	0.0013	54	415,000,000	41,500,000

(1) Somatic effects, Continental basis.

(2) Base case health effect calculated from the Continental value of 9.7 per year as

$$\left(\frac{250}{450}\right)\left(\frac{50}{82}\right)\left(\frac{1}{10}\right)(9.7) = 0.33 \text{ per year}$$

Base case flux is 250 pCi/m^2-sec. Health effects for other flux levels obtained by ratio.

(3) From Table XII.

(4) 0.6 meters of clay reduces the calculated flux to 8.5 pCi/m^2-sec. The cost shown includes an additional 0.4 meters of Soil A and the total incremental health effects averted to 5 pCi/m^2-sec. of 5.3/year.

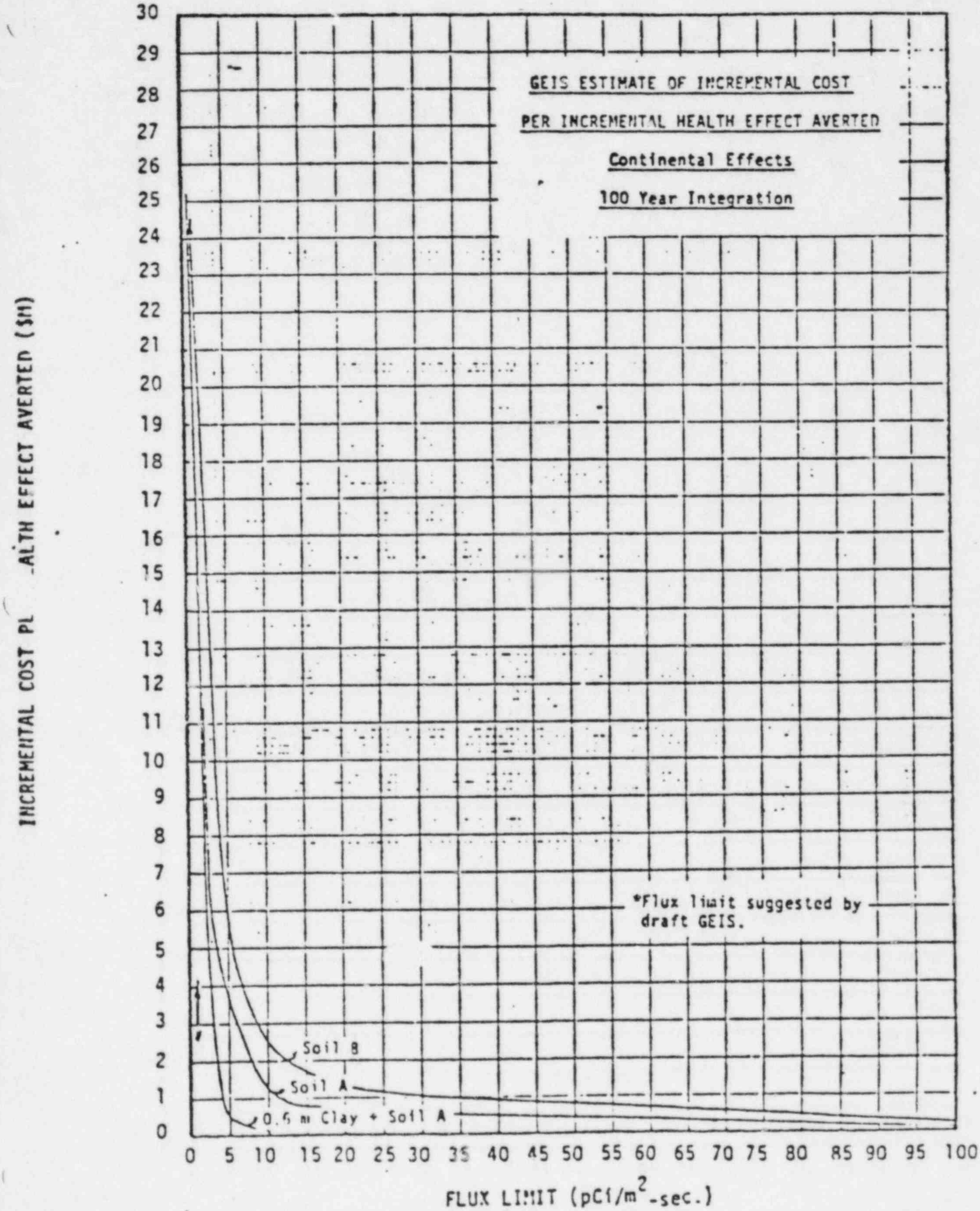

GEIS ESTIMATE OF INCREMENTAL COST
PER INCREMENTAL HEALTH EFFECT AVERTED
Continental Effects
100 Year Integration
*Flux limit suggested by draft GEIS.
Soil B
Soil A
0.6 m Clay + Soil A
INCREMENTAL COST PE_ALTH EFFECT AVERTED ($M)
FLUX LIMIT (pCi/m²-sec.)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

FIGURE A6-3

GEIS ESTIMATE OF INCREMENTAL COST

PER INCREMENTAL HEALTH EFFECT AVERTED

Continental Effects

100 Year Integration

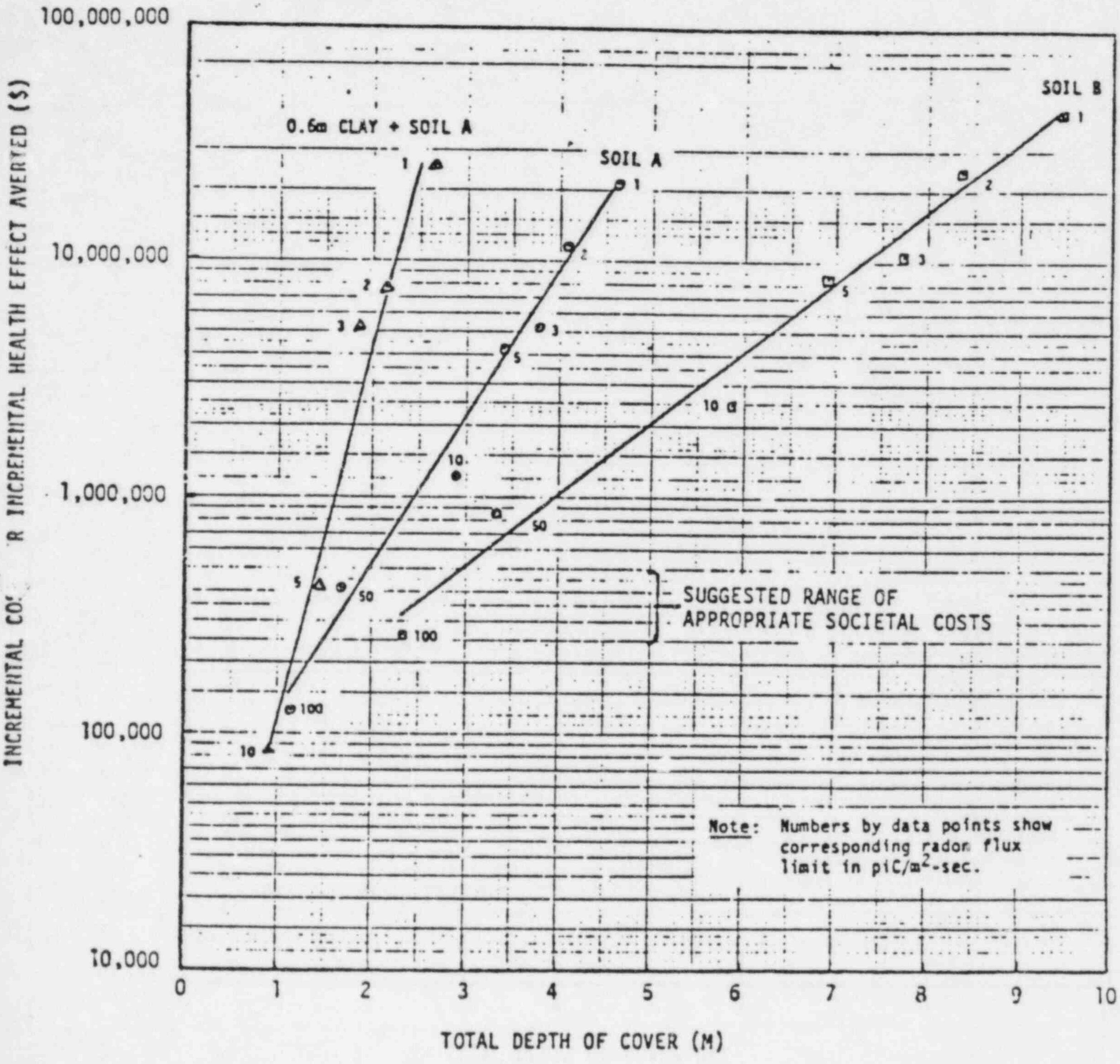
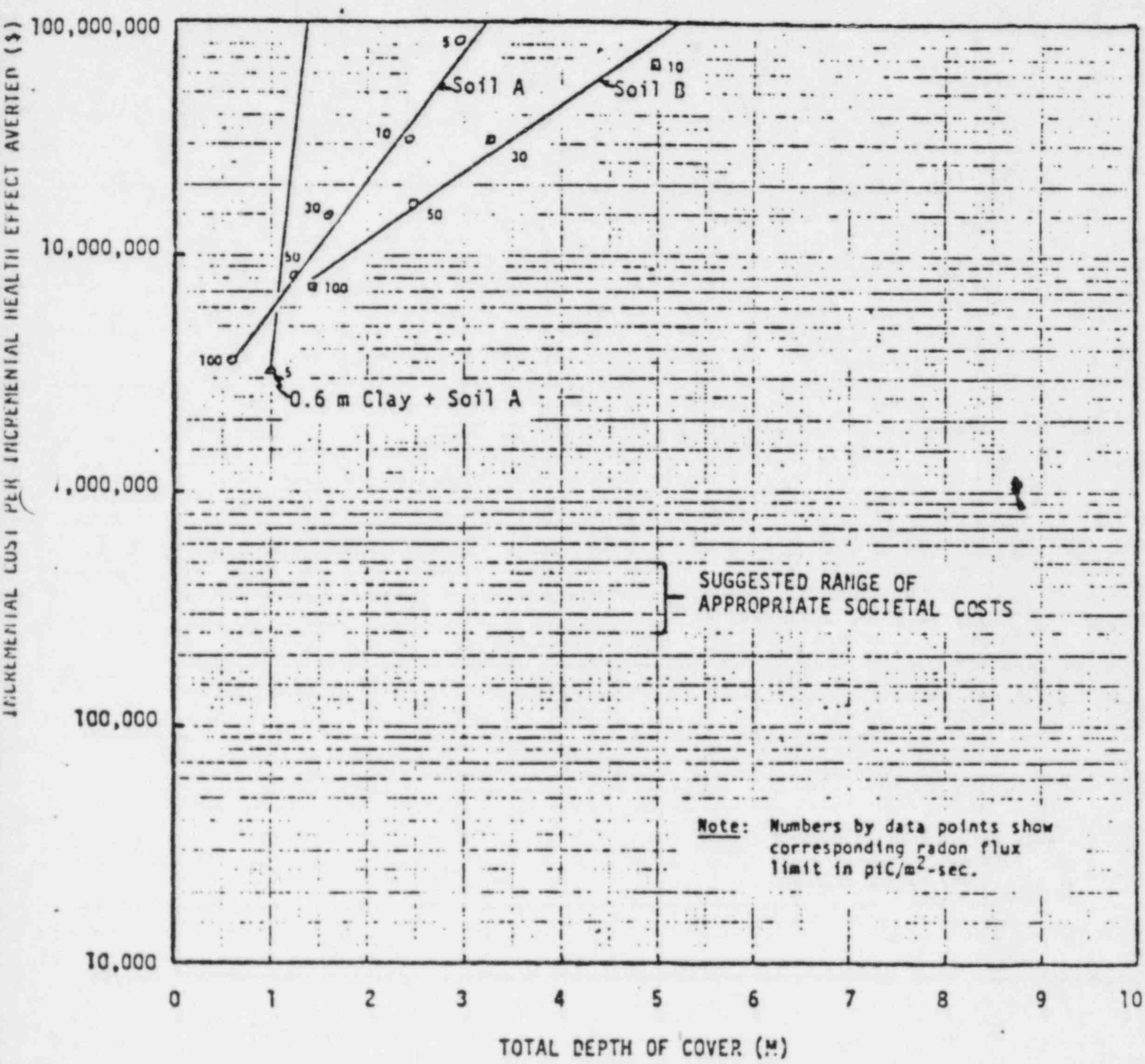


FIGURE 4c-4

AMC ESTIMATE OF INCREMENTAL

COST PER INCREMENTAL HEALTH EFFECT AVERTED

Continental Effects 100 Year Integration



A-5

FIGURE 5

The Colorado MINING ASSOCIATION

DAVID R. COLE
Secretary and Manager

June 29, 1981

Radiation and Hazardous Wastes Control Division
Colorado Department of Health
4210 E. 11th Avenue
Denver, Colorado 80220

Attention: Frank A. Traylor, M.D.
Executive Secretary, Colorado Board of Health

Re: Proposed Revisions to Colorado Radiation Control Regulations.

Dear Dr. Traylor:

The Colorado Mining Association herewith submits its comments on the revisions to the subject regulations submitted by the Radiation and Hazardous Wastes Control Division at the June 17 hearing. These comments are submitted pursuant to the Board's order of June 19 extending the deadline for public comment to July 1, 1981.

We recognize that certain changes have been made in the proposed regulations, and we appreciate the consideration accorded our comments by the Board and the Division. However, we remain convinced that our proposed revisions offer a regulatory program which is a practical equivalent to UMTRCA and the NRC guidelines, yet will preserve the uranium industry in Colorado. We believe that the regulations proposed by the Division are unnecessarily stringent and, in some cases, inconsistent with their underlying statutory authority. For these reasons, CMA must restate its intention to seek judicial review of certain of the regulations, if the Division's proposals are adopted.

We would be pleased to meet with representatives of the Division at any time to discuss our comments.

Sincerely yours,

David R. Cole

DRC/z

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SUPPLEMENTAL COMMENTS ON PROPOSED REVISIONS
SUBMITTED BY RHWCD ON JUNE 17, 1981.

RH §3.9.4.1

Commentors restate their objection to this provision. The changes recommended by the Division do not cure the overbroad scope of this regulation, which is its fundamental defect. Even with the changes recommended by the Division, the regulation can still be read to allow the Division to require surety arrangements to cover the licensee's failure to comply with the terms of the license--regardless of whether such terms relate to decontamination, decommissioning and reclamation of the licensed facility. This in turn allows the rule to function as an all-purpose civil penalty provision, for which there is no authority in the Colorado Radiation Control Act.

RH §3.9.4.2

At the hearing on June 17, there was an extensive colloquy between Board members and certain parties regarding what standards the Division might apply to self-insurance, including collateral bonding by a licensee. Commentors would point out that collateral bonds are authorized under the regulatory program administered by the Office of Surface Mining under the Surface Mining Control and Reclamation Act, and OSM has promulgated detailed regulations prescribing the conditions of collateral bonding. See, e.g., 30 CFR Part 806, and commentary at 44 Fed. Reg. 15113, et seq. (March 13, 1979). Commentors would refer the Board and the Division to these regulations and commentary as possible guidance in drafting revisions to this section.

Commentors would also refer the Board to the mined land reclamation program currently being administered by the Texas Railroad Commission. Under applicable Texas law, self-insurance is permitted where the licensee can show a history of financial solvency and continuous operation sufficient for self-insurance. §131.203 of the Texas Natural Resources Code provides as follows:

> The Commission may accept the bond of the operator itself, without separate surety, if the operator demonstrates to the satisfaction of the Commission the existence of a suitable agent to receive service of process and a history of financial solvency and continuous operation sufficient to self-insure or bond the amount.

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According to Jerry Hill, Director of the Mined Land Reclamation Division of the Texas Railroad Commission, the Texas self-insurance program "has worked very well for both uranium and coal mining operations". (Telephone conversation between Henry Ipsen and Mr. Hill, July 1, 1981). A copy of the relevant sections of the Texas Natural Resources Code pertaining to bonds and deposits for mining operations is hereto attached for your information.

Finally, it is our understanding that EPA has now decided to allow facilities regulated under RCRA's financial responsibility requirements to self-insure for closure requirements and for liability against third party damages. See Bureau of National Affairs, Current Developments, May 15, 1981, at page 91.

RH §3.9.5.4.2

Commentors are in general agreement with the latest proposed revisions to this section (refer to Exhibit #1 submitted by the Radiation and Hazardous Wastes Control Division). However, commentors restate their objection to the use of the "minimum charge" of $250,000. As noted in our supplemental comments submitted on June 17, this sum is much more than would normally be required for surveillance of small reclaimed heap leach operations.

RH §3.10.6.4.2

Commentors restate their objection to this provision. There is no need for a qualified engineer or scientist to conduct the inspection. A general mill foreman or an hourly technician can perform this function if properly trained. Daily checks for leaks, cracks, etc., coupled with monitoring and annual or semi-annual inspections by a "qualified engineer or scientist" will meet the concerns at a substantial cost savings to the operator.

Daily inspections would require that more than one qualified scientist or engineer be employed to inspect the system. The costs could easily exceed $100,000 per year.

An additional point is that the term "qualified" is rather vague. Operations may not have a soils scientist on the payroll, but it is likely to have a foreman or technician whose actual experience in the field makes him or her an excellently "qualified" daily inspector.

The original proposal provided the flexibility to allow the operator to find the most cost-effective method for

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fulfilling the requirement. The original language should be used.

The daily inspection of the entire system may not be needed. Portions of the system may warrant only a monthly, quarterly, or annual inspection. The benefits of environmental monitoring may also obviate the need for daily inspections of some portions of the system. The criterion should allow the operator to provide for such inspections of some portions of the system.

CRITERION 5

Commentors submit the following additional change to 5(a). The change proposed below would bring this regulation into compliance with the groundwater protection standards prescribed in the recently-enacted H.B. 1468 (see §25-8-505(3)):

> (a) STEPS SHALL BE TAKEN TO REDUCE SEEPAGE OF TOXIC MATERIALS INTO GROUNDWATER TO THE MAXIMUM EXTENT ~~REASONABLY ACHIEVABLE~~ PRACTICABLE, TO THE END THAT NO SIGNIFICANT POLLUTION WILL RESULT THEREFROM, OR THAT THE POLLUTION, IF ANY, WILL BE LIMITED TO WATERS IN A SPECIFIED LIMITED AREA FROM WHICH THERE IS NO SIGNIFICANT MIGRATION. ANY SEEPAGE WHICH DOES OCCUR SHALL NOT RESULT IN DETERIORATION OF EXISTING GROUNDWATER SUPPLIES FROM THEIR CURRENT OR POTENTIAL USE. THE FOLLOWING SHALL BE CONSIDERED TO ACCOMPLISH THIS: ....

BEFORE THE
ENVIRONMENTAL IMPROVEMENT BOARD
OF THE
STATE OF NEW MEXICO

IN THE MATTER OF PROPOSED
AMENDMENTS TO THE RADIATION
PROTECTION REGULATIONS

PROPOSED FINDINGS BY THE URANIUM ENVIRONMENTAL SUBCOMMITTEE AND KERR-McGEE NUCLEAR CORPORATION

AUGUST 7, 1981

The Uranium Environmental Subcommittee ("UES") and Kerr-McGee Nuclear Corporation ("Kerr-McGee") submit their proposed Findings to the Environmental Improvement Board ("Board") in connection with the Proposed Amendments to the Radiation Protection Regulations which were the subject of hearings held on June 11-13, 1981.

Background: Uranium Mills and Uranium Milling

1. Uranium mills process uranium ore into uranium concentrate.

Kerr-McGee Comments p. 1.

'illing of uranium is an essential step in the production of uranium for nuclear power reactors.

'rr-McGee Comments p. 1.

a strategic material; its continued production is vital 's security as well as to assure adequate provision of 1es and factories.

.onal testimony of Mr. Robert Luke attached as .ix B to Kerr-McGee Comments. Letter, Senator .iitt to President Reagan, attached as Appendix C to err-McGee Comments.

ranium ore typically contains only 1 to 5 pounds of uranium per ton, 90 to 97% of which is removed in the milling process. The "mill tai':ngs" are the material remaining after the uranium is removed.

Kerr-McGee Comments p. 1.

5. Uranium mill tailings contain small amounts of residual uranium as well as naturally occurring quantities of all other radionuclides in the uranium (U-238) decay series.

Kerr-McGee Comments p. 1.

6. Uranium mill tailings are native rock from which a significant portion of the radioactive content has been removed; their natural radioactivity has been diluted rather than enhanced by milling.

Tr. at 486 (Dr. Evans); Hearings on H.R. 11698; H.R. 12229; H.R. 12937, H.R. 12535, H.R. 13049, and H.R. 13650 before the Subcommittee on Energy and Power of the Committee on Interstate and Foreign Commerce, 95th Congress, 2d Session, 217 (1978) (NRC Chairman Hendrie), cited in Kerr-McGee Comments at p. 7.

7. Uranium mill tailings are generally stored in retention systems called "tailings ponds" or "tailings piles".

Kerr-McGee Comments p. 1.

8. Uranium mill tailings are sometimes reinserted into underground uranium mines. This process is known as uranium sand backfilling.

Tr. 1336-39 (Mr. Shelley); Kerr-McGee Comments p. 1.

9. There is no evidence that anyone has ever been harmed by exposure to uranium mill tailings.

Tr. 558-59 (Dr. Evans); Tr. 142 (Mr. Miller); II GEIS A-35 (NRC Exhibit 1, vol. 2, p. A-35).

II. <u>Statutes and Legal Developments</u>

10. This Board is required under New Mexico law to consider all the factors relevant to the matter before it. These factors include, but are not limited to: -- the "character and degree of injury or interference with health, welfare, animal and plant life, property and the environment"; -- the "public interest, including the social, economic and cultural value of the regulated activity and the social, economic and cultural effects of environmental degradation"; and -- the "technical practicability, necessity for, and economic reasonableness of reducing, eliminating, or otherwise taking action with respect to environmental degradation."

NMSA §79-1-9; Tr. 24 (Cubia Clayton).

11. The regulations under consideration are modelled on NRC's Uranium Mill Licensing Requirements. 45 Fed. Reg. 65521 (Oct. 3, 1981). Under the Uranium Mill Tailings Radiation Control Act (Mill Tailings Act), this Board need not adopt those regulations if they are not practicable in this State. NRC has taken positions con-

trary to this view in various forums. However, at the three lengthy days of hearings conducted in this proceeding, NRC's hearing counsel (Mr. Fonner) specifically agreed that this Board has "a legal duty" to examine whether the regulations at issue are practicable.

> *42 USC §2021(o)(2) (practicability language); NRC's opposition to Motion for Stay in Kerr-McGee Nuclear Corporation, et al v. NRC, No. 80-2043 at p. 27 (May 15, 1981) (NRC position that State may not examine practicability); Tr. 728 (Mr. Fonner)*

12. NRC has taken the position that New Mexico must adopt regulations conforming to that agency's Uranium Mill Licensing Requirements and obtain an amended discontinuance agreement by November 8, 1981 or the State will automatically lose jurisdiction as of that date.

> *Tr. 20-22 (Cubia Clayton); Letter, Mr. Ahearne (NRC) to Governor King.*

13. Under the Mill Tailings Act, EPA is to promulgate standards of general applicability for active uranium processing sites which NRC and states such as New Mexico are then to implement. EPA has not yet even proposed such standards, yet NRC has issued its Uranium Mill Tailings Licensing Requirements. The uranium industry has challenged the validity of NRC's regulations, in part on the ground that NRC acted unlawfully in proceeding in the absence of EPA standards.

> *Section 275 of the Atomic Energy Act, 42 U.S.C. §2022; Kerr-McGee Comments 13-16; Kerr-McGee Nuclear Corporation, et al, v. NRC, 10th Cir. No. 80-2043 and consolidated cases; American Mining Congress, et al. v. NRC, 10th Cir. No. 80-2271.*

III. Requirements for Siting:
NRC-Advocated Criterion One; Industry Criterion One.

A. NRC-Advocated Criterion One

14. The version of Criterion One advocated by NRC contains certain considerations applicable to evaluating proposed or existing tailings sites; other considerations are contained in Criterion Four as advocated by NRC. The version of Criterion One advanced by NRC also emphasizes isolation of tailings for "thousands of years" and requires that tailings be disposed of in a manner such that "no active maintenance is required to preserve [the] stability of the site."

Proposed Criteria One and Four.

15. Criterion One as advanced by NRC is not practicable and is not adopted.

(a) New versus existing. Proposed Criterion One is equally applicable both to new and to existing sites. Future application of the considerations pertaining to siting to existing sites may result in attempts to require that tailings at existing sites be moved to new disposal sites even if such a move is unnecessary to protect the public health or safety or the environment. The expense of such a move would be in the tens of millions and perhaps hundreds of millions of dollars. It would also endanger the public and harm the environment due to the movement of millions of tons of tailings. The Criterion is thus unreasonable and impracticable for New Mexico, a State with many long-established mills with millions of tons of tailings already in existence.

Kerr-McGee Comments 17; Tr. 1331.

(b) *Longevity*. Technology does not exist to assure the isolation of tailings for thousands of years. Moreover, the course of future events is too difficult to predict for an objective of isolation of tailings for thousands of years to be manageable. Tailings disposal should be based on reasonable stabilization coupled with management; it should not be based on costly and speculative schemes permanently to isolate the piles solely by engineering controls for what in effect is perpetuity.

> *Tr. 479-81 (Dr. Evans); Letter, Greenleigh (DOE) to Selander (EPA) attached as Appendix A to Kerr-McGee Comments.*

(c) *Bar on active maintenance*. The bar on active maintenance contained in proposed Criterion One is based upon the rationale that our government will fail. This rationale is inconsistent with the Constitution (which presumes that our government will last in perpetuity), the Mill Tailings Act (which does not bar active maintenance) and the New Mexico Continued Care Fund (which is specifically intended to provide for stabilization involving maintenance). The bar on active maintenance is also unreasonable and unduly expensive.

> *Kerr-McGee Comments 31-35;*
> *Marbury v. Madison, 5 U.S. 137 (1803).*
> *IV Collected Works of Abraham Lincoln 264;*
> *NMSA §§74-3-6 & 7*

B. <u>Industry-Advocated Criterion One</u>.

16. The version of Criterion One sponsored by industry relates only to the siting of facilities. It contains considerations corresponding to the siting considerations in the versions of Criterion One and Four

advocated by NRC. Industry Criterion One distinguishes between new and existing facilities. It provides that new facilities must be evaluated for remoteness from population centers, minimization of disruption by natural forces, compliance with stringent radiation controls, protection from 100-year flood events, possible below-grade disposal, and location away from earthquake danger. It provides that existing facilities must be evaluated for compliance with the same stringent radiation controls and protection from 100-year flood events.

17. Criterion One as proposed by the UES and Kerr-McGee is adopted. The Criterion takes into proper account the distinction between new and existing facilities. It assures that the public health and safety is protected and environmental degradation is prevented in siting decisions.

UES/Kerr-McGee Comments at 8-19 (many cites to record)

IV. <u>Requirements Applicable to Small Disposal Sites; NRC-Advocated Criterion Two; Industry Criterion Two</u>

A. <u>NRC-Advocated Criterion Two</u>

18. NRC-advocated Criterion Two provides that wastes from small operations must be disposed of at existing large mill tailings disposal sites unless this disposal is impracticable or clearly outweighed by countervailing benefits.

Proposed Criterion Two.

19. Criterion Two as advocated by NRC is not practicable and is not adopted in its current form. The proposed Criterion appears to create a heavy presumption in favor of disposal of wastes from small operators at existing large sites. However, there has been

no demonstration that existing large sites are willing or able to accept such wastes. Moreover, there has been no showing that such a presumption is desireable to protect the public health or safety, or to protect the environment.

UES/Kerr-McGee Comments at 20-21.

B. Industry-Advocated Criterion Two.

20. The version of Criterion Two proposed by industry calls for consideration to be given to disposal of wastes from small-scale operators at large mill tailings sites. The Criterion calls for a balancing of the costs versus the benefits of that approach.

21. Criterion Two as proposed by the UES and Kerr-McGee is adopted. It provides for due consideration of disposal of small-scale wastes at large facilities but does not create any inflexible presumption in favor of such disposal. Rather, it provides for the weighing of relevant factors. In a sense, it better corresponds to NRC's basic position on siting (i.e., that relevant factors be considered and weighed) than does the formulation advanced by NRC.

UES/Kerr-McGee Comments at 20-21.

V. Stabilization: NRC-Advocated Criteria Three, Four and Six; Industry-Advocated Criterion Three

A. NRC-Advocated Criteria Three, Four and Six

22. The requirements pertaining to stabilization sponsored by NRC are scattered through three separate Criteria: numbers Three, Four and Six. *Criterion Three* creates a heavy presumption in favor of below grade disposal, branding that alternative as "[t]he 'prime option'". It also limits above grade disposal to those situations where below grade disposal is not "practicable." Even in those

situations, it creates a kind of performance standard, requiring that above grade disposal "provide reasonably equivalent isolation of the tailings" to below grade disposal. *Criterion Four* specifies a variety of "design criteria" to which adherence is required. For example, it specifies a preference for 10h:1v slopes, and a presumption against slopes steeper than 5h:1v. It calls for either rock cover or "[a] full self-sustaining vegetative cover" on the slopes and (somewhat more ambigiously) on the top of the pile. The Criterion also specifies that the rocks used must be at least cobble size, and "free from cracks, seams and other defects" and that the rocks not be "weak, friable, or laminated aggregate." The Criterion calls for design to promote deposition. In addition, Criterion Four contains a number of matters relating to siting, e.g., location to protect against a "probable maximum flood," location to provide wind protection, and location to protect from earthquakes. (These elements of Criterion Four are dealt with in the context of Criterion One (Siting).) Finally, *Criterion Six* limits radon emanation from the stabilized tailings to less than $2pCi/m^2$-sec and requires that sufficient earth cover, but in any event no less than three meters, be placed on the tailings. The Criterion calls for reduction of gamma radiation from the tailings to background.

23. Criteria Three, Four and Six as advocated by NRC are not practicable and are not adopted.

(a) *Below Grade Disposal*. The inflexible presumption in favor of below grade is unsupported and is not practicable in New

Mexico. There is no evidence in the record that below grade disposal is necessary to provide reasonable assurance that the stabilized tailings are protected against erosion. To the contrary, the evidence indicates that above grade disposal systems will provide as reasonable assurance as below grade systems of erosion resistance and will be significantly less expensive.

Tr. 1107-10, 1122, 1126-27, 1130 (Mr. Wulff). UES/Kerr-McGee Comments at 12-13.

(b) *Slopes*. The preference for slopes of 10h:1v and the presumption against slopes steeper than 5h:1v is unsupported and is not practicable in New Mexico. The evidence indicates that above grade tailings retention systems may be designed with slopes more steep than 5h:1v and yet provide as reasonable assurance of resisting erosion as slopes less steep than 5h:1v and at less cost. Moreover, the checkerboard pattern of land ownership in New Mexico is such that owners of the large tailings piles in this state do not control sufficient surrounding land to contour slopes to values such as 10h:1v. Finally, making slopes less steep will mean that more earth cover must be employed to cover the tailings (assuming that a minimum of three meters were in all events required as NRC proposes). This would translate into more disruption of natural landscape and degradation of the environment.

Tr. 1345 (Mr. Shelley); Report by Sergent, Hauskins & Beckwith (UES Exhibit).

(c) *Rock or vegetative cover*. The requirement that tailings be covered with non-friable, seamless, unblemished rock or a "full self-sustaining vegetative cover" is unsupported and is not practicable in New Mexico. There is no evidence that such a requirement is necessary in order to provide adequate protection against erosion. Moreover, the climate of New Mexico is such that the vegetative cover called for could not be assured and non-friable, seamless, unblemished rock is not reasonably available.

Tr. 1335-36; Tr. 1351 (perfect rock unavailable); Tr. 1349-50 (climate)

(d) *Design for deposition*. The requirement that the stabilized tailings be designed to promote deposition is vague, unnecessary and impracticable as drafted. It is likely that tailings piles in New Mexico are naturally depositional. The requirement as applied here is impracticable because regulations and regulated industry will lack guidance as to how it may be applied. Moreover, there is no evidence that the requirement is necessary to provide protection against erosion.

Report of Sergent, Hauskins & Beckwith at 12 (UES Exhibit).

(e) *$2pCi/m^2$-sec radon emanation standard*. NRC's proposed $2pCi/m^2$-sec radon emanation standard is unduly burdensome, unreasonable, not required to protect the public health, and impracticable in New Mexico.

(i) Radon (an inert, radioactive gas) is released from uranium mill tailings due to the decay of radium, itself a decay product ("daughter") of uranium.

UES/Kerr-McGee Comments 26; Kerr-McGee Comments 24-25.

(ii) NRC regards radon as the primary hazard posed by uranium mill tailings.

Tr. at 253-54 (Hubert Miller).

(iii) The radon released by mill tailings is a small fraction of the radon released naturally from all soils.

Tr. 468-70 (Dr. Evans);
Tr. 1012 (Dr. Schiager);
Letter, Evans to Mills (Ker. McGee Exhibit No. 2).

(iv) Increased levels of radon from uranium mill tailings cannot be detected more than 1/4 to 1/2 mile from even unstabilized uranium mill tailings piles.

Tr. 454-65 (Dr. Evans); Shearer & Sill, Evaluation of Atmospheric Radon in the Vicinity of Uranium Mill Tailings, 17 Health Physics 77-88 (Kerr-McGee Exhibit No. 2); Letter, Greenleigh (DOE) to Selander (EPA), dated July 15, 1981 (Appendix A to Kerr-McGee Comments).

(v) Epidemiological studies unanimously indicate that there are no adverse health effects from increased exposure to radiation, including radiation attributable to exposure to radon, at the levels associated with uranium mill tailings.

Tr. 457-58, 484-85 and 562-67 (Dr. Evans); Hickey, et al., Low Level Ionizing Radiation and Human Mortality: Multi-Regional Epidemiological Studies, 40 Health Physics 625 (1981) (Kerr-McGee Exhibit No. 7); Frigerio, et al. The Argonne Radiological Impact Program (AHIP)-I. Carcinogenic Hazard from Low-Level, Low-rate Radiation (Argonne Nat'l Lab Report ANL/ES-26, Part 1) (1973) (Kerr-McGee Exhibit No. 5); High Background Radiation Research Group (China), Health Survey in High Background Radiation Areas in China, 209 Science 877 (1980) (Kerr-McGee Exhibit No. 6); Gopal-Ayengar, et al, Evaluation of Long-Term Effects of High Background Radiation on Selected Population Groups on the Kerala Coast in Peaceful Uses of Atomic Energy, Vol. 11, Proc. 45th Int. Conf. Peaceful Uses of Atomic Energy pp. 31-51 (1971) (Kerr-McGee Exhibit No. 4); Cullen, et al, Dosimetric and Cytogenetic Studies in Brazilian Areas of High Natural Activity, 19 Health Physics 165 (1970) (Kerr-McGee Exhibit No. 3).

(vi) Prominent experts are of the opinion that exposure to low levels of radiation, including radiation from radon at the levels associated with mill tailings, has no adverse health effects and that whatever radiological effects occur are remedied by the body's natural repair mechanisms.

> *Tr. 495-96 (Dr. Evans); Tr. 426-28 (Dr. Branagan); In the Matter of Duke Power Co. (Perkins Nuclear Station Units 1, 2 and 3), 8 NRC 87, [1975-78 Transfer Binder] Nuclear Reg. Rep. (CCH) ¶30,312 at p. 28669 (1978).*

(vii) There is no evidence that public exposure to uranium mill tailings or radiation attributable to uranium mill tailings has resulted in any adverse health effects.

> *Tr. at 558-59 (Dr. Evans);*
> *Tr. at 142 (Mr. Miller);*
> *II GEIS at A-35 (admission by NRC).*

(viii) In the absence of any actual evidence of adverse health effects, NRC assumes that some health effects may occur on the basis of the linear nonthreshold model. This model hypothesizes that because very high doses of radiation cause health effects, there will be proportional effects at low levels. This model has been criticized as overstating the likely risk from exposure to low level radiation.

> *Kerr-McGee Comments 25; Tr. 458-59 (Dr. Evans); Hickey, et al., Low Level Ionizing Radiation and Human Mortality: Multi-Regional Epidemiological Studies, 40 Health Physics 625 (Kerr-McGee Exhibit 7).*

(ix) Even under the linear nonthreshold model, NRC calculates the maximum hypothetical risk from even totally *unregulated* tailings piles to be only about 1 in 70,000,000 to the average member of the public for three times the number of mills now in existence.

Tr. at 241-42 (Hubert Miller); Kerr-McGee Comments 26-27.

(x) The hypothetical risk estimated by NRC is much less than many actual risks (e.g., the risk of driving a car, the risk of being a farmer, the risk of drinking milk, the risk of being struck by lightening) commonly and ordinarily accepted in our society.

OSHA Testimony of Professor Richard Wilson submitted as a Kerr-McGee Exhibit at Transcript 229-37; Kerr-McGee Comments at 26.

(xi) NRC claims that the risk to someone living atop or near the pile would be greater. However, the stabilized tailings pile will be under government control so it is unreasonable to assume that someone will be living on the site. Moreover, the New Mexico Continued Care Fund will provide additional assurance that persons will not dwell on the site. In addition, no excess radon from the pile can be detected more than 1/4 to 1/2 mile from the site, even in the downwind direction. Finally, there is no evidence that any person in New Mexico is being exposed to increased levels of radon due to mill tailings. Thus, the risk even to persons near the pile is slight.

See, e.g., Shearer & Sill, Evaluation of Atmospheric Radon in the Vicinity of Uranium Mill Tailings, 17 Health Physics 77-88 (Kerr-McGee Exhibit No. 2).

(xii) The hypothetical risk calculated by NRC overstates the maximum hypothetical risk attributable to radon. A recent study by a panel of prominent experts from EPA, DOE, England, Germany and Canada indicates that the risk to the public per unit exposure to radon can be no greater than 1/3 that employed by NRC and that the risk may in fact be zero. Experts have estimated that NRC's estimates are excessive by factors of ten to forty.

> *Evans, et al, Estimate of Risk from Environmental Exposure to Radon -222 and Its Decay Products, 390 Nature 90 (March 12,1981) (UES Exhibit No. B) Tr. 476 (Dr. Evans) (NRC off by factor of ten); Tr. 987 (Dr. Schiager) (NRC off by factor of forty).*

(xiii) NRC's decision to limit radon flux to $2pCi/m^2$-sec was not based upon health effects, but instead was based upon a desire to reduce radon emanation to "average" natural background levels. This has no apparent connection to the protection of the environment or of public health and safety. Moreover, the natural radon flux in many areas of the country (in particular, in mining and milling areas) is significantly higher.

> *Tr. 958-59 (Dr. Schiager); Tr. 480(Dr. Evans)*

(xiv) Fifteen feet or more of New Mexico soil will be required to attain a $2pCi/m^2$-sec limit. The proposed standard thus will result in considerable environmental degradation and expense and is impracticable in New Mexico.

> *Tr. 666 (Dr. Rogers); Tr. 480 (Dr. Evans).*

(xv) DOE does not support the proposed $2pCi/m^2$-sec radon emanation standard. Instead, DOE advocates retention of the current radon concentration standards of 3pCi/l radon off-site and 30pCi/l radon on-site.

> *Letter, Greenleigh (DOE) to Selander (EPA), dated July 15, 1981) attached as Appendix A to Kerr-McGee Comments. N.M. Radiation Regulations, Part 4, App. A (current regulation).*

(f) *Minimum of Three Meters Cover.* The requirement that tailings be covered with no less than three meters of cover is unnecessary, unreasonable, and impracticable in the State of New Mexico. Erosion can be controlled with less than three meters cover under the conditions encountered in New Mexico. Requiring three meters cover will result in significant degradation of the environment due to excavation and movement of large quantities of soil and rock. It additionally will be hazardous to workers and to the public as well as unduly expensive. NRC's requirement of a minimum of three meters of cover appears to be in part based on that agency's assumption that our government will fail, an assumption contrary to the Constitution, the Mill Tailings Act, and the rationale behind New Mexico's Continued Care Fund.

Tr. 479-480, 483, 508 (Dr. Evans); Report by Sergent, Hauskins & Beckwith (UES Exhibit).

(g) *Gamma radiation*. The requirement that gamma radiation be reduced to background levels is ambigious and impracticable to implement in New Mexico since background gamma may fluctuate greatly. It is not acceptable for the same reasons NRC rejected a reference to background levels of radon emanation in arriving at that agency's 2pCi/m^2-sec radon standard.

B. Industry-Advanced Criterion Three

24. The UES and Kerr-McGee have developed detailed requirements relating to stabilization in their proposed Criterion Three. The industry proposal has collected all the stabilization requirements into that single Criterion. The Criterion is based upon a straight forward performance standard. That standard, set forth in ¶1, requires that sufficient cover be placed on the tailings to provide protection from erosion comparable to two feet of sandy clay soil

cover on a tailings pile 50 feet high with slopes of 5h:1v. The comparable protection may be provided by increasing the soil cover, by using rock, by terracing, or by other methods; however, in no event may a cover of earthen materials placed on the tailings be less than two feet. Paragraph (2) of the Criterion provides that proposed non-earthen cover must meet the same performance standard. Paragraph (3) provides for control of runoff so as to prevent washouts. The Paragraph establishes a performance standard for the pertinent controls based upon catchment systems. That standard calls for design to control a rainfall event of 5 inches over a 9 hour period. Paragraph (4) requires reasonable steps to initiate vegetative cover on portions of the stabilized tailings not covered with rock. However, it does not require actual establishment of vegetative cover. Paragraph (5) provides that earthen cover shall be taken from near the tailings area unless less expensive material is available elsewhere. It also provides for use of clayey soils and sandstone or rock of comparable resistance to erosion. Paragraph (6) requires fencing of the stabilized tailings. Paragraph (7) provides that a substantial portion of the rock fragments shall be of sufficient size to resist displacement of expected human and animal traffic. Paragraph (8) provides for protection against gully erosion by headcutting. Paragraph (9) requires design to protect against a hundred-year flood.

25. Criterion Three as proposed by the UES and Kerr-McGee is adopted.

(a) *Performance standard.* The performance standard set forth in paragraph 1 of industry's proposal is supported by the evidence and provides assurance of adequate protection against the effects of erosion.

(i) The primary reason for use of cover in tailings stabilization is to protect the tailings pile from erosion.

Tr. 486 (Dr. Evans)
Tr. 1010 & 1021 (Dr. Schiager)

(ii) Because technology does not exist to assure stabilization for prolonged periods of time and because future events are uncertain, it is unreasonable to require cover which will last for more than about two centuries.

Tr. 483 (Dr. Evans)

(iii) One or two feet of soil will provide reasonable assurance of resisting erosion for at least two centuries or more when properly applied and maintained.

Tr. 508 (Dr. Evans); see also id. at 479. Report by Sergent, Hauskins & Beckwith at 2, 8 and App. B; Tr. 1059 (Dr. Schiager); Tr. 1120 (Mr. Wulff); Tr. 655 (Dr. Rogers)

(iv) Funds and institutions are already available in New Mexico to assure that the required cover is maintained in perpetuity. New Mexico has established a Continued Care Fund for the purpose of "remedying or preventing situations which may be harmful to the health, safety, welfare or property of the people" which might arise in connection with inactive uranium processing facilities. This Fund is intended to provide for on-going surveillance and maintenance of such facilities in perpetuity. Uranium mills operating in this State must each contribute $1,000,000 to the

Fund. Such contributions are in fact being made. Kerr-McGee has completed its $1,000,000 contribution.

NMSA §§74-3-6 & 7; Tr. 1345 (Mr. Shelley)

(v) Two feet of soil cover will also essentially eliminate gamma radiation from the tailings and will reduce radon flux by a factor of about two to ten. In order to assure that gamma radiation is eliminated and that all tailings are adequately covered, the Criterion provides that at least two feet of earthen cover must be placed on the tailings

Letter, Evans to Mills at pp. 4-5 (Kerr-McGee Exhibit No. 1) (gamma); Tr. 479 (Dr. Evans) (radon); Tr. 659 (Dr. Rogers) (radon)

(b) *Non-earthen material*. Paragraph (2) of industry's proposal requires that non-earthen material employed as cover comply with the same performance standard and is therefore reasonable.

(c) *Control of runoff*. Paragraph (3) of industry's proposal provides additional assurance that the cover will resist erosion. Paragraph (3) requires the licensee to take steps to control runoff from the covered tailings to prevent major washouts. Various means, including the use of additional cover or the construction of catchment systems may be employed to achieve this end on a site-specific basis. Such systems must be designed to control a rainfall event of 5 inches over a 9 hour period. The record indicates that a rainfall event of 5 inches over a 9 hour period is the most rain that can reasonably be expected to occur at tailings sites in New Mexico. Accordingly the performance standard specified in the paragraph is reasonable and conservative.

UES/Kerr-McGee Comments 39-41; Tr. 1277-81 (Dr. Sabol); Report of Sergent, Hauskins & Beckwith, Appendix A (UES Exhibit).

(d) *Vegetative cover.* Vegetative cover is not required to meet the performance standards devised for control of erosion and will be difficult if not impossible to establish in the areas where uranium is milled in New Mexico. However, in order to provide some additional assurance that erosion is controlled, it is prudent to require that reasonable steps, such as seeding, fertlizing, and mulching be employed to initiate a vegetative cover over those portions of the tailings not covered with rock. In that fashion, such vegetation as will be self-sustaining will be given a reasonable opportunity to assert itself promptly upon stabilization.

Tr. 1349-50 (Colloquy between Messrs. Hensley & Shelley)

(e) *Source and type of earthen cover.* The expense of providing cover should be minimized to the extent possible while providing for proper compliance with applicable standards. It is accordingly appropriate to derive cover material from sources near the tailings unless less expensive material is available elsewhere. Clay, sandy clay and clayey sand have favorable characteristics with respect to erosion resistance and are therefore preferred soils if economically practicable. Moreover, these kinds of soils are more readily able to attenuate radon. Sandstone rock is readily available and, under conditions in New Mexico, highly erosion resistant.

Tr. 1335; Report by Sergent, Hauskins & Beckwith (UES Exhibit).

(f) *Fencing*. It is reasonable to require the licensee to fence the property after stabilization to assist the government, which will have control of the site, in preventing trespassing. This will also provide additional assurance that the cover will not be disrupted.

UES/Kerr-McGee Comments 41; Letter, Greenleigh (DOE) to Selander (EPA), attached as App. A to Kerr-McGee Comments.

(g) *Rock fragments*. A significant part of the rock fragments employed at the tailings are required to be of such size that they may not be significantely displaced by expected livestock and human traffic.

UES/Kerr-McGee Comments 41

(h) *Head-cutting*. Head-cutting refers to the tendency of a gully to erode toward the source in its flow. In order to assure protection against head-cutting, the licensee is required to take reasonable steps to control gully erosion.

Tr. 1109 & 1130 (Mr. Wulff).

(i) *Flood protection*. Tailings impoundments should be stabilized in such a fashion to protect against floods which may reasonably be expected at their location. A 100-year flood is an extremely unlikely event. Thus, requiring safeguards against a flood of that magnitude is adequate for purposes of flood protection.

UES/Kerr-McGee Comments 12-15; Tr. at 1261 et seq. (Dr. Sabol)

VI. Groundwater Protection:
NRC-Advocated Criterion Five; Industry-Advocated Criterion Four.

A. NRC-Advocated Criterion Five.

26. NRC-sponsored Criterion Five contains extensive provisions relating to groundwater protection. It creates a strong presumption against any contamination of groundwater, providing that steps be taken to reduce seepage of water contaminants into groundwater to the maximum extent reasonably achievable. It calls for installation of bottom liners and leakage detection systems, conservation of water, dewatering of tailings, and neutralization. The Criterion also provides for restoration of groundwater at existing sites "to its potential use before milling operations began to the maximum extent practicable." The Criterion creates a presumption in favor of isolation of tailings from groundwater. Other requirements, including informational requirements, are specified.

27. The version of Criterion Five advocated by NRC is not acceptable in its current form. The proposed Critirion is beyond the jurisdiction of this Board, as well as unreasonable and impracticable in New Mexico.

(a) *Jurisdiction*. The Water Quality Control Commission and the State Engineer are responsible in this State for matters pertaining to groundwater protection.

(b) *Unreasonableness*. New Mexico has extensive regulations pertaining to groundwater protection with which all uranium mills must comply. These existing regulations are fully adequate to protect groundwater in the State of New Mexico. The proposed additions will confer no benefit and impose great additional expense.

Tr. 1210-16 & 1222 (Mr. Hoffman)

(c) *Sand backfill.* Sand backfilling using uranium mill tailings is essential in New Mexico to prevent catastrophic collapse of open stopes, to protect overlying aquifers, to safeguard miners, and to remove ore values. No alternatives are available. The proposed regulation unreasonably fails to take these factors into account and is impracticable in New Mexcio.

Tr. 1336-39 (Mr. Shelley)

B. Industry-Advocated Criterion 4.

28. Industry-advocated Criterion 4 provides that licensees comply with applicable New Mexico groundwater regulations.

29. The version of Criterion 4 proposed by the UES and by Kerr-McGee is adopted. This version is identical to a sentence in the NRC-sponsored proposal. It is within the jurisdiction of the Board. The existing regulation provides adequate protection to groundwater in the State of New Mexico.

Tr. 1210-16 & 1222 (Mr. Hoffman)

VII. Preoperational Monitoring: NRC-Advocated Criterion 7; Industry-Advocated Criterion 5.

30. The NRC and industry sponsored versions of the preoperational monitoring criterion are similar. Both require pre-operational monitoring. However, the NRC-advocated version requires collection of "complete" baseline data on the milling site and its environs for at least one year. The industry version calls for collection of "necessary" data for simply one year.

31. The NRC-advocated version is not practicable and is not adopted. The requirement of "complete" data is unnecessarily ambiguous and

the provision allowing discretion to require baseline data for more than one year may unduly impede construction of milling facilities.

32. The industry version (Criterion 5) is adopted. The version of Criterion 5 proposed by industry calls for a one-year monitoring program prior to construction of a new mill which will generate *necessary* baseline data. This version is less ambiguous and poses less risk of imposition of unduly burdensome requirements.

VIII. Airborne Effluent Releases:
NRC-Advocated Criterion 8; Industry Advocated Criterion 6.

A. NRC-Advocated Criterion 8.

33. NRC advocated Criterion 8 specifies stringent restrictions on airborne emissions. It also imposes detailed monitoring requirements. It moreover requires that tailings be wetted or chemically stabilized "to prevent or minimize blowing and dusting to the maximum extent reasonably achievable." The NRC version also creates a preferance against institutional controls (e.g., extending the site boundary) as a means of complying with pertinent emission limits.

34. The NRC sponsored requirement is not practicable and is not adopted in New Mexico. New Mexico regulations already impose stringent limitations on airborne emissions from uranium mills. No evidence has been presented to the Board indicating that more stringent controls are required. The evidence indicates that airborne emissions (e.g., dust from tailings) does not pose a radiological hazard at current levels. No reason has been advanced to foreclose institutional controls.

E.g., Tr. 986 (Dr. Evans).

B. Industry Advocated Criterion 6.

35. The version of the criterion proposed by industry provides for additional controls relating to airborne emissions. The industry proposal also specifies that consideration be given at new sites to phased covering of tailings.

36. Criterion 6 as proposed by the UES and Kerr-McGee is adopted. It incorporates Part 4 of the New Mexico Radiation Regulations. It takes into account practicable limitations in the accomplishment of compliance with such standards. Licensees have been complying with Part 4 for years and there is no known health effect resulting from compliance therewith. The practicable limitations at existing, as opposed to new sites, are taken into account.

IX. Financial Criteria:
NRC-Advocated Criterion 9; Industry-Advocated Criterion 8.

A. NRC-Advocated Criterion 9.

37. NRC-advocated Criterion 9 defines measures required to assure financing of the reclamation called for by these regulations. The NRC version forbids self insurance. It allows only surety bonds, cash deposits, certificates of deposit, deposits of government securities, irrevocable letters or lines of credit. No NRC or EID witness testified in favor of this Criterion.

38. Bonding is not available to uranium companies at this time. Kerr-McGee, the largest producer in the United States, has been unable to obtain a quote for a bond.

Tr. Vol. 6, pp. 1155, 1180, 1183; Letter from Surety Association of America, submitted as Kerr-McGee Exhibit; Tr. Vol. 6, pp. 1180, 1183.

39. There is no reasonable basis to forbid self insurance. It is an adequate means to accomplish financial security.

(Tr. Vol. 6, p. 1154, 1160, 1163-66).

40. NRC's hearing counsel (Mr. Fonner) acknowledged that self-insurance under appropriate conditions could provide adequate assurance of financial responsibility.

Tr. 1177-78 (Mr. Fonner).

B. Industry Advocated Criterion 8.

41. The industry version allows self insurance, the measures allowed under the NRC version, and other means satisfactory to the Division.

42. The Industry-Advocated Criterion 8 is adopted. It provides for self insurance which is the only practicable means available in many instances to obtain financial security. Self insurance means showing financial responsibility and performance capability based on the legal obligations of the licensee and the continuing existence of unobligated working capital and net worth (including assets which may be liquidated or estimate of cash flow) sufficient to assure performance of decommissioning requirements. The Industry-Advocated draft adequately delimits the conditions which must be met to qualify for self insurance, as well as the procedures necessary to determine the amunt of financial ability necessary to perform the stabilization requirements.

See UES/Kerr-McGee Comments p. 55-57.

X. Long Term Surveillance:
NRC-Advocated Criterion 10; Industry-Advocated Criterion 9.

A. NRC-Advocated Criterion 10.

43. The NRC-Advocated Criterion 10 provides for a final disposition of wastes in accordance with Parts 1, 3, 4 and 12 of this Board's regulation. It also provides for inspections of stabilized tailings at least once a year by the division. However, it also states that "long-term goal" is "no active maintenance." The industry version of this criterion (No. 9) in the industry draft (is comparable except that it deletes the language pertaining to no active maintenance and substitutes a reference to the Continued Care Fund.

44. The NRC advocated version of Criterion 10 is not adopted. The NRC sponsored version of Criterion 10 is inconsistent with this state's Continued Care Fund into which each mill will contribute one million dollars not only for surveillance but for appropriate maintenance. It also restates the bar on maintenance rejected in the discussion of Criterion 1.

B. Industry-Advocated Criterion 9.

45. The funds generated by the Continued Care Fund are adequate to finance long term surveillance and such maintenance as may be required under the Board's regulations. Accordingly, industry-advocated Criterion 9 is adopted.

XI. Site and By-Product Material Ownership:
NRC-Advocated Criterion 11; Industry-Advocated Criterion 9.

46. The NRC-Advocated Criterion 11 requires transfer of title to tailings to the United States or New Mexico prior to termination of a mill license. The Industry-Advocated Criteria 9 closely tracks the NRC version but differs in several material respects.

47. In New Mexico, the ownership of land and mineral and royalty rights are often divided among different owners. It is difficult, expensive, and sometimes impossible to acquire all outstanding interests in title to property used for milling operations. The NRC-Advocated Criterion 10 does not adequately take these considerations into account.

UES/Kerr-McGee Comments at p. 77-78.

48. The Industry-Advocated Criterion 9 is adopted. It takes into account impediments to acquisition and transfer of title in New Mexico and vests in the Division the necessary authority to balance the risk to public health and safety against the feasibility of title transfer. Without such a provision, the title transfer requirement would work an impermissible hardship on the licensee.

XII. Proposed Section 3-300N

49. Proposed Section 3-300N provides that all processing of radioactive ores shall be conducted in such a manner as to provide a reasonable assurance that a member of the public will not be exposed to in excess of 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ of the body as a result of planned discharges of radioactive material, radon and its daughters excepted. The proposed regulation also requires that the licensee maintain a monitoring program for purposes of evaluating compliance. No EID or NRC witness testified in favor of Section 3-300N.

50. Average background radiation in the United States ranges from about 100 mrem to 250 mrem.

Tr. 457 (Dr. Evans); Tr. 996 (Dr. Schiager)

51. An ordinary chest x-ray gives about 50 mrem exposure.

    Tr. 941 (Dr. Davis).

52. The difference in annual whole body exposure rate between Albuquerque and Santa Fe is about 25 mrem.

    Tr. 996.

53. Epidemiological evidence unanimously indicates that increased exposures of 25 mrem (and, indeed of many times that amount) will result in no discernible adverse health effects and may in fact be beneficial.

    Tr. 457-58, 484-85 and 562-67 (Dr. Evans); Hickey, et al., Low Level Ionizing Radiation and Human Mortality: Multi-Regional Epidemiological Studies, 40 Health Physics 625 (1981) (Kerr-McGee Exhibit No. 7); Frigerio, et al. The Argonne Radiological Impact Program (AHIP)-I. Carcinogenic Hazard from Low-Level, Low-rate Radiation (Argonne Nat'l Lab Report ANL/ES-26, Part 1) (1973) (Kerr-McGee Exhibit No. 5); High Background Radiation Research Group (China), Health Survey in High Background Radiation Areas in China, 209 Science 877 (1980) (Kerr-McGee Exhibit No. 6); Gopal-Ayengar, et al, Evaluation of Long-Term Effects of High Background Radiation on Selected Population Groups on the Kerala Coast in Peaceful Uses of Atomic Energy, Vol. 11, Proc. 45th Int. Conf. Peaceful Uses of Atomic Energy pp. 31-51 (1971) (Kerr-McGee Exhibit No. 4); Cullen, et al, Dosimetric and Cytogenetic Studies in Brazilian Areas of High Natural Activity, 19 Health Physics 165 (1970) (Kerr-McGee Exhibit No. 3).

54. Prominent experts on radiation are of the opinion that even doubling the level of background radiation will not be harmful.

    Tr. 456-47 (Dr. Evans)

55. The standards contained in proposed Section 3300N are unnecessary to protect the public health or to prevent environmental degradation.

    Tr. 486 (Dr. Evans) (no radiological problem); Tr. 997 (Dr. Schiager)

56. Compliance with the standards proposed in Section 3-300N will be difficult and expensive.

Tr. 997 (Dr. Schiager); Kerr-McGee Comments 46.

57. Proposed Section 3-300 N is not adopted.

Respectfully submitted,

THE URANIUM ENVIRONMENTAL SUBCOMITTEE

By [signature]
Edward E. Kennedy, Chairman

and

KERR-McGEE NUCLEAR CORPORATION

By [signature]
William J. Shelley, Vice President,
Nuclear Licensing and Regulation
Kerr-McGee Corporation

HEALTH ENVIRONMENT department

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DEPUTY SECRETARY

August 5, 1981

Mr. George Hensley, Chairman
Environmental Improvement Board
P. O. Box 10158
Albuquerque, NM 87114

Dear Mr. Hensley:

In response to your request of June 23, 1981, the Environmental Improvement Division has prepared an analysis of the eleven criteria proposed to be added to existing Radiation Protection Regulations. The analysis includes revised language and a narrative explaining and supporting the revisions.

The Division has also prepared a summary of the proposed revisions, with a brief explanation of the changes for each criterion.

This Division appreciates the opportunity to respond to your request with proposals that are considered to be environmentally effective and practicable in New Mexico.

Sincerely,

Thomas E. Baca
Director

SUMMARY OF REVISIONS

25 Millirem Standard: Retain essential language, with deletion of concepts already in existing regulations (new 3-300.M).

Criterion 1 (alternative site selection of criteria): Combine necessary elements of Criteria 1 and 4, with deletion of details not considered essential (new 3-300.K.1). Delete existing 3-300.K. to avoid repetition.

Criterion 2 (avoid proliferation of small waste sites): Retain language originally proposed (new 3-300.N.).

Criterion 3 (consideration of below grade disposal): Combine part of this criterion with elements of Criterion 4 for analysis of alternative tailings management methods (new 3-300.K.2). Delete "prime option" language for below grade disposal.

Criterion 4 (site and design criteria): Combine essential elements of this criterion with Criteria 1 and 6. Delete reference to "probable maximum flood".

Criterion 5 (reduction of ground water contamination): Modify existing 3-300I to include compliance with New Mexico Water Quality Control Commission regulations.

Criterion 6 (three meter earth cover and reduction of radon emanation): Modify existing 12-300B to include reclamation concepts, with deletion of reference to a minimum three meters of cover and two $pCi/m^2 sec.$ radon flux limit.

Criterion 7 (one year of preoperational baseline monitoring). Retain essential language with minor modification (new 3-300.0).

Criterion 8 (minimize air-borne effluent releases): Retain essential language, with the deletion of nonessential details (new 4-160.G.).

Criterion 8A (daily inspections): Retain essential language, with minor changes (new 3-300.P and 4-420.D).

Criterion 9 (surety arrangements): Retain necessary elements, delete nonessential language, and allow a provision for self insurance or any other acceptable surety arrangement (new 3 -315).

Criterion 10 (annual inspection of stabilized sites): Modify existing 12-300.E to include this concept. Delete nonessential language.

Criterion 11 (site and tailings ownership): Defer further action pending decision by the New Mexico Supreme Court on Writ of Certiorari.

INTRODUCTION TO SPECIAL CRITERIA

The Division recommends the deletion of this introduction.

EID PROPOSALS DATED MAY 8, 1981

ATTACHMENT 1

D R A F T

PROPOSED ADDITION OR REVISION

DELETED

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PART 3 APPENDIX A - Special Criteria Relating to Uranium or Thorium Milling or Source Material Extraction Processes and the Disposition of Tailings or Wastes . . .

25 (NEW MATERIAL)

3-300.M

Any application submitted for the use of Source Material, as defined in Section 1-102.Z.Z., for Uranium or Thorium Milling or "byproduct material," as defined in Section 1-102.G(2), shall contain proposed written specifications relating to milling operations or source material extraction operations and the disposition of the byproduct material to meet the requirements and objectives set forth in Appendix A to Part 3. Each application must clearly demonstrate how the requirements set forth in Appendix A to Part 3 will be complied with. Existing Uranium Milling Licensees shall submit appropriate documentation meeting the requirements of Appendix A to Part 3 in connection with license renewal applications or within nine months from the effective date of this Appendix which ever occurs first.

25 MILLIREM STANDARD

The Division recommends the adoption of this standard as originally proposed, except for the deletion of the last two sentences.

EID REVISED PROPOSALS-AUGUST 5,1981

It is recommended that material originally proposed as 3-300N be adopted as 3-300M, with the deletion of the last two sentences:

3-300M. All processing of radioactive ores, including uranium mills or other source material extraction facilities, shall be conducted by the licensee in such a manner as to provide reasonable assurance that the annual dose equivalent does not exceed 25 millirems to the whole body, 75 millirems to the thyroid and 25 millirems to any other organ of any member of the public as a result of exposures to planned discharges of radioactive material, radon and its daughters excepted, to the general environment. ~~The licensee shall maintain an adequate radiation monitoring system and document to support his evaluation of compliance. This information shall be available to the Division for review at any reasonable time.~~

BASIS FOR RECOMMENTATION:

This recommendation was supported at the hearing by public interest groups and the Nuclear Regulatory Commission (Tr. 815-16, 847-48, 891, Exhibits: G.T. Davis p. 1-2).

The Division and the NRC explained the necessity to adopt this recommendation so that State will be able to continue the regulation of uranium processing activities (Tr. 21-65, 815-16). The NRC testified that the Environmental Protection Agency "25 Millirem" regulation (40 CFR 190) became effective on December 1, 1980 (Tr. 815-16).

The last two sentences of the original proposal have been deleted because they are covered in existing regulations (4-200 and 3-400).

CRITERION 1

The Division recommends the deletion of this criterion as originally proposed, and the adoption of new language.

EID PROPOSALS DATED MAY 8, 1981

I. Technical Criteria

DELETED

Criterion 1 - In selecting among alternative tailings disposal sites or judging the adequacy of existing tailings sites, the following site features, which determine the extent to which a program meets the broad objective of isolating the tailings and associated contaminants from man and the environment during operations and for thousands of years thereafter without ongoing active maintenance, shall be evaluated:

a. remoteness from populated areas;

b. hydrologic and other natural conditions as they contribute to continued immobilization and isolation of contaminants from usable groundwater sources; and

c. potential for minimizing erosion, disturbance, and dispersion by natural forces over the long term.

The site selection process shall be an optimization to the maximum extent reasonably achievable in terms of these site features.

In the selection of disposal sites, primary emphasis shall be given to isolation of tailings or wastes, a matter of having long term impacts, as opposed to consideration only of short term convenience or benefits, such as minimization of transportation or land acquisition costs. While isolation of tailings will be a function of both site and engineering design, overriding consideration shall be given to siting features given the long term nature of the tailings hazards.

Tailings shall be disposed of in a manner that no active maintenance is required to preserve stability of the site.

EID REVISED PROPOSALS-AUGUST 5, 1981

In lieu of Criterion 1, the following amendments to the existing regulations are proposed:

1. Delete existing 3-300K: ~~In-support-of-uranium-mill license-applications,-the-applicant-shall-perform-an-analysis-of-viable-tailings-management-alternatives-including below-grade-disposal-and-alternative-sites.~~

2. Insert the following as new 3-300K.1 (for 3-300K.2 see Criterion 3).

RECOMMENDATION:

3-300.K.1 Environmental reports for uranium mills shall include an alternative site analysis which has the broad objective of identifying a site which will provide long-term isolation of the tailings and associated contaminants from man and the environment. In selecting among alternative tailings disposal sites or judging the adequacy of existing tailings sites, the following site criteria shall be evaluated: a) remoteness from populated areas; b) hydrologic and other natural conditions that contribute to the continued isolation of contaminants from usable groundwater; c) location where long-term geologic stability exists and gully erosion is not a hazard; d) reduction of upstream catchment area to minimize flooding risk; e) protection from wind erosion of tailings; f) suitability for long-term reclamation and minimal continued maintenance and monitoring; g) location where seismic risk is within acceptable limits; and h) locations which minimize conflicts with other environmental values, such as archeological, wildlife and recreational.

BASIS FOR RECOMMENTATION:

These siting criteria are considered by the EID to be essential elements in the evaluation of uranium mill applications. They have been used as guidelines by the Division for the past two years and have been found to be practicable to apply and acceptable to industry for both new and existing mills.

They represent criteria that should be optimized, to the maximum extent reasonably achievable, during the site evaluation process. This recommendation combines elements from Criterion 1 and 4 of the original proposal.

This recommendation does not require active operators to relocate present tailings to an alternative site. What this language does require is the preparation of a study which evaluates these criteria for present tailings sites and compares them with characteristics of alternative sites. Once a study of this type has been completed for an existing or proposed site, it would not require duplication for subsequent relicensing applications.

Testimony at the hearing supported the evaluation of these criteria (Tr. 848-52, 892-94). With the exception of the requirement to evaluate the maximum probable flood, there was no objection at the hearing to the adoption of this requirement.

There was substantial testimony regarding the "maximum probable flood" language in the original proposal (Tr. 758, 1261-1326).

Based on the testimony of the NRC and uranium industry consultants, the Division concludes that the maximum probable flood language is not necessary, and that a requirement to evaluate the "reduction of upstream catchment area to minimize flooding risk" is more appropriate (Tr. 1317).

CRITERION 2

The Division recommends the adoption of this criterion as originally proposed.

EID REVISED PROPOSALS-AUGUST 5, 1981

It is recommended that Criterion 2 be adopted as originally proposed and added to the regulations as 3-300N.

RECOMMENDATION:

3-300N. To avoid proliferation of small waste disposal sites and thereby reduce perpetual surveillance obligations, byproduct material from in-situ extraction operations, such as residues from solution evaporation or contaminated control processes, and wastes from small remote above ground extraction operations shall be disposed of at existing large mill tailings disposal sites; unless, considering the nature of the wastes, such as their volume and specific activity, and the costs and environmental impacts of transporting the wastes to a large disposal site, such offsite disposal is demonstrated to be impracticable or the advantages of onsite disposal clearly outweigh the benefits of reducing the perpetual surveillance obligations.

BASIS FOR RECOMMENTATION :

This recommendation is considered by the EID to be important in reducing the numbers of radioactive waste disposal sites. Future monitoring and maintenance can be more efficiently and economically conducted with a smaller number of sites.

This criterion was supported by the testimony of several public interest groups at the hearing (Tr. 850-51, 893-9A) and there was no substantive opposition.

CRITERION 3

The Division recommends the deletion of this criterion as originally proposed, and the adoption of new language.

Criterion 3 - The "prime option" for disposal of tailings is placement below grade, either in mines or specially excavated pits (that is, where the need for any specially constructed retention structure is eliminated). The evaluation of alternative sites and disposal methods performed by mill operators in support of their proposed tailings disposal program (provided in applicants' environmental reports) shall reflect serious consideration of this disposal mode. Where full below grade burial is not practicable, the size of retention structures, and size and steepness of slopes of associated exposed embankments, shall be minimized by excavation to the maximum extent reasonably achievable or appropriate given the geologic and hydrologic conditions at a site. In these cases, it must be demonstrated that an above grade disposal program will provide reasonably equivalent isolation of the tailings from natural erosional forces.

DELETED

EID REVISED PROPOSALS AUGUST 5, 1981

In lieu of Criterion 3, the following addition as new 3-300K.2 is proposed:

RECOMMENDATION

3-300.K.2 : Environmental reports for uranium mills shall include an analysis of alternative tailings management methods. The analysis shall include an evaluation of the engineering and economic feasibility, as well as the health, safety and environmental benefits of : 1) below-grade disposal in trenches and mines, 2) neutralization and recycling of tailings liquid ; 3) dewatering of tailings material; 4) any other method proposed by the applicant.

BASIS FOR RECOMMENDATION:

The concept of below-grade tailings disposal as a preferred or prime option was discussed extensively at the hearing (Tr. 87, 246-49, 803, 850-52, 1099-1142). Testimony from the NRC indicated that below-grade disposal is not required, but must be given serious consideration along with other options. Therefore, the orginally proposed language describing below-grade disposal as the "prime option" has been deleted. Although disposal in trenches and mines is considered by the Division to be a desirable alternative, all other options will be considered. Testimony by a consultant for the uranium industry (Tr. 1111-12) suggested that instead of the "prime option" lanuage, it would "be better to simply require evaluation of all the feasible alternatives and permit each selection to be made on its own merits, subject to the State's review and concurrence".

This EID proposal does not require present operators to remove existing tailings and depose of them in below-grade trenches and mines. It requires no action except the presentation of information on tailings management alternatives. The concepts of neutralization, recycling and dewâtering appeared in the originally proposed criterion 5 and are judged by the Division to be important environmental considerations. Again, what is required is an analysis of feasibility. It is not a requirement to initiate neutralization, recycling and dewatering schemes in existing mills. There was no testimony at the hearing objecting to a requirement to perform these feasibility studies.

It is considered important by the Division to have the opportunity to review industry-projected costs of tailings management alternatives. Under 4-100.B of existing regulations it is stated that "every reasonable effort should be made to maintain radiation exposure...as low as reasonably achievable... taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety".

CRITERION 4

The Division recommends the deletion of this criterion.

Criterion 4 - The following site and design criteria shall be adhered to whether tailings or wastes are disposed of above or below grade:

DELETED

a. Upstream rainfall catchment areas must be minimized to decrease erosion potential and the size of the probable maximum flood which could erode or wash out sections of the tailings disposal area.

b. Topographic features shall provide good wind protection.

c. Embankment and cover slopes shall be relatively flat after final stabilization to minimize erosion potential and to provide conservative factors of safety assuring long term stability. The broad objective should be to contour final slopes to grades which are as close as possible to those which would be provided if tailings were disposed of below grade; this could, for example, lead to slopes of about 10 horizontal to 1 vertical (10h:1v) or less steep. In general, slopes should not be steeper than about 5h:1v. Where steeper slopes are proposed, reasons why a slope less steep that 5h:1v would be impracticable should be provided, and compensating factors and conditions which make such slopes acceptable should be identified.

d. A full self-sustaining vegetative cover shall be established or rock cover employed to reduce wind and water erosion to negligible levels.

Where a full vegetative cover is not likely to be self-sustaining due to climatic or other conditions, such as in semi-arid and arid regions, rock cover shall be employed on slopes of the impoundment system. The Division will consider relaxing this requirement for extremely gentle slopes such as those which may exist on the top of the pile.

The following factors shall be considered in establishing the final rock cover design to avoid displacement of rock particles by human and animal traffic or by natural processes, and to preclude undercutting and piping:

e. Shape, size, composition, and gradation of rock particles (excepting bedding material average particle size shall be at least cobble size or greater);

f. Rock cover thickness and zoning of particles by size; and

g. Steepness of underlying slopes.

Individual rock fragments shall be dense, sound, and resistant to abrasion, and shall be free from cracks, seams, and other defects that would tend to unduly increase their destruction by water and frost actions. Weak, friable, or laminated aggregate shall not be used. Shale, rock laminated with shale and charts shall not be used.

DELETED

Rock covering of slopes may not be required where top covers are very thick (on the order of 10m or greater); impoundment slopes are very gentle (on the order of 10h:1v or less); bulk cover materials have inherently favorable erosion resistance characteristics; and, there is negligible drainage catchment area upstream of the pile and good wind protection as described in points (a) and (b) of this Criterion.

Deleted

Furthermore, all impoundment surfaces shall be contoured to avoid areas of concentrated surface runoff or abrupt or sharp changes in slope gradient. In addition to rock cover on slopes, areas toward which surface runoff might be directed shall be well protected with substantial rock cover (rip rap). In addition to providing for stability of the impoundment system itself, overall stability, erosion potential, and geomorphology of surrounding terrain shall be evaluated to assure that there are no ongoing or potential processes, such as gully erosion, which could lead to impoundment instability.

h. The impoundment shall not be located near a capable fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand. As used in this criterion, the term "capable fault" has the same meaning as defined in the Nuclear Regulatory Commission's Regulations (Section III(g) of Appendix A of 10 CFR 100 dated January 1, 1978, see Attachment 3). The term "maximum credible earthquake" means that earthquake which would cause the maximum vibratory ground motion based upon an evaluation of earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material.

i. The impoundment, where feasible, should be designed to incorporate features which will promote deposition. For example, design features which promote deposition of sediment suspended in any runoff which flows into the impoundment area might be utilized; the object of such a design feature would be to enhance the thickness of cover over time.

DELETED

EID REVISED PROPOSALS AUGUST 5, 1981

It is recommended that Criterion 4, as submitted to the EIB, be deleted.

BASIS FOR RECOMMENDATION:

The basic principles stated in Criterion 4 have been included in the proposed new 3-300K.1 (siting criteria) and additions to existing 12-300B (reclamation criteria). Further explanation is included in Division comments on Criterion 1 and 6. Other reclamation design criteria are included in Part 12 of existing regulations.

CRITERION 5

The Division recommends the deletion of this criterion as originally proposed, and the addition of new language to an existing regulation.

Criterion 5 - Steps shall be taken to reduce seepage of water contaminants into groundwater to the maximum extent reasonably achievable. Any seepage which does occur shall not result in deterioration of existing groundwater supplies from their current or potential uses. The following shall be considered in order to accomplish this objective:

DELETED

a. Installation of low permeability bottom liners (where synthetic liners are used, a leakage detection system shall be installed immediately below the liner to ensure major failures are detected if they occur. This is in addition to the groundwater monitoring program conducted as provided in Criterion 7. Where clay liners are proposed or relatively thin in-situ clay soils are to be relied upon for seepage control, tests shall be conducted with representative tailings solutions and clay materials to confirm that no significant deterioration of permeability or stability properties will occur with continuous exposure of clay to tailings solutions. Tests shall be run for a sufficient period of time to reveal any effects if they are going to occur (in some cases, deterioration has been observed to occur rather rapidly after

b. Mill process designs which provide the maximum practicable recycle of solutions and conservation of water to reduce the net input of liquid to the tailings impoundment.

c. Dewatering of tailings by process devices and/or in-situ drainage systems (At new sites, tailings shall be dewatered by a drainage system installed at the bottom of the impoundment to lower the phreatic surface and reduce the driving head for seepage, unless tests show tailings are not amenable to such a system. Where in-situ dewatering is to be conducted, the impoundment bottom shall be graded to assure that the drains are at a low point. The drains shall be protected by suitable filter materials to assure that drains remain free running. The drainage system shall also be adequately sized to assure good drainage).

d. Neutralization to promote immobilization of water contaminants.

Where groundwater impacts are occurring at an existing site due to seepage, action shall be taken to alleviate conditions that lead to excessive seepage impacts and restore groundwater quality to its potential use before milling operations began to the maximum extent practicable. The specific seepage control and groundwater protection method, or combination methods, to be used must be worked out on a site-specific basis. Technical specifications shall be prepared to control installation of seepage control systems. A quality assurance, testing, and inspection program, which includes supervision by a qualified engineer or scientist, shall be established to assure the specifications are met.

DELETED

While the primary method of protecting groundwater shall be isolation of tailings and tailings solutions, disposal involving contact with groundwater will be considered provided supporting test and analyses are presented demonstrating that the proposed disposal and treatment methods will not degrade groundwater from current or potential uses. Compliance with New Mexico Water Quality Control Commission Regulations is required.

In support of a tailings disposal system proposal, the applicant/operator shall supply information concerning the following:

e. The chemical, physical, and radioactive characteristics and quantities of the waste solutions.

f. The characteristics of the underlying soil and geologic formations, particularly as they will control transport of contaminants and solutions. This shall include detailed information concerning extent, thickness, uniformity, shape, and orientation of underlying strata. Hydraulic gradients and conductivities of the various formations shall be determined as well as effective porosity and equilibrium distribution coefficients for radionuclides of concern.

This information shall be gathered from borings and field survey methods taken within the proposed impoundment area and in surrounding areas where contaminants might migrate to usable groundwater and surface water. The information gathered on boreholes shall include both geologic and geophysical logs in sufficient number and degree of sophistication to allow determining significant discontinuities, fractures, and channeled deposits of high hydraulic conductivity. If field survey methods are used, they should be in addition to and calibrated with borehole logging. Hydrologic parameters such as permeability shall not be determined on the basis of laboratory analysis of samples alone; a tests) shall be conducted to assure actual field properties are adequately understood. Testing shall be conducted to allow estimating chemi-sorption attenuation properties of underlying soil and rock.

DELETED

Location, extent, quality, capacity and current uses of any groundwater at and near the site.

Furthermore, steps shall be taken during stockpiling of ore to minimize penetration of radionuclides into underlying soils; suitable methods include lining and/or compaction of ore storage areas.

EID REVISED PROPOSALS-AUGUST 5, 1981

The Division recommends that Criterion 5, as submitted to the Board, be deleted and the following change be made in the existing regulations 3-300I.

RECOMMENDATION:

3-300I. The application for a radioactive material license for a uranium mill or a commercial radioactive waste disposal site, for any renewal thereof, or for an amendment thereto as described in 3-300 H (3), shall demonstrate to the satisfaction of the Director that the activity for which such license is requested will comply with all laws and regulations enforceable by the Division including the regulations of the New Mexico Water Quality Control Commission.

BASIS FOR RECOMMENDATION:

The UMTRCA of 1978, as amended, does not require regulations (standards) identical to those of the Nuclear Regulatory Commission (NRC) but rather the Act requires the State to adopt regulations that ". . . are equivalent, to the extent practicable, or more stringent than, standards adopted and enforced by the Commission for the same purpose . . ." The Division takes the position that the regulations of the New Mexico Water Quality Control Commission (NMWQCC), are at least equivalent and in some respects more stringent than those of the NRC. (Tr. 25,86, 205,855,1260). In addition, the Commission's regulations have been formulated expressly for the water resource characteristics existing in New Mexico and, having withstood the test of use and public scrutiny, are without question more practicable in New Mexico than those of the NRC. (Tr. 1210).

This regulatory position concerning Criterion 5 has not to date been challenged by the NRC, industry or the public, except to the extent that the NMWQCC regulations do not include certain radionuclides. Additional important radionuclides, such as Thorium-230 and Lead-210, are covered by Part 4 of the New Mexico Radiation Protection Regulations (the standards of Part 4 are equivalent to NRC 10 CFR Part 20, Appendix B, Concentrations In Air And Water Above Natural Background).

CRITERION 6

The Division recommends the deletion of this criterion as originally proposed, and the addition of new language to an existing regulation.

Criterion 6 - Sufficient earth cover, but not less than three meters, shall be placed over tailings or wastes at the end of milling operations to result in a calculated reduction in surface exhalation of radon emanating from the tailings or wastes to less than two picocuries per square meter per second. In computing required tailings cover thicknesses, moisture in soils in excess of amounts found normally in similar soils in similar circumstances shall not be considered. Direct gamma exposure from the tailings or wastes should be reduced to background levels. The effects of any thin synthetic layer shall not be taken into account in determining the calculated radon exhalation level. If non-soil materials are proposed to reduce tailings covers to less than three meters, it must be demonstrated that such materials will not crack or degrade by differential settlement, weathering, or other mechanism, over long term time intervals. Near surface cover materials (i.e., within the top three meters) shall not include mine waste or rock that contains elevated levels of radium; soils used for near surface cover must be essentially the same, as far as radioactivity is concerned, as that of surrounding surface soils. This is to ensure that surface radon exhalation is not significantly above background because of the cover material itself.

DELETED

EID REVISED PROPOSALS-AUGUST 5, 1981.

The Division recommends that Criterion 6, as submitted to the Board, be deleted and the following addition be made to the existing regulations: 12-300B.

RECOMMENDATION:

12.300.B Waste retention systems shall be stabilized, as soon as practicable after inactivation, in such a manner that transport of radionuclides is controlled to acceptable levels in terms of applicable environmental standards. The need for long term maintenance and monitoring after stabilization shall be minimized and, to the maximum extent practicable, eliminated. Stabilization measures shall minimize erosion, disturbance, and dispersion by natural forces.

BASIS FOR RECOMMENDATION:

It is readily evident from the hearing record and the exhibits thereto that Criterion 6, directed primarily to control of radon, received considerable attention and was perhaps the most controversial proposal submitted to the Board. It is the opinion of the Division that this is unfortunate because it diverts attention from the broader aspects of requirements for reclamation that the Division considers of greater importance. These are all of the physical and institutional measures that will be needed to ensure that tailings are stabilized in a manner that will "--minimize or eliminate radiation health hazards to the public."

(UMTRCA, Sec. 2.(b), Findings and Purposes), including control of radon. The Division believes that the important requirements for reclamation of tailings can and will be accomplished, on a case by case basis, by use of the authority provided by existing and proposed new regulations including Part 4 (Radiation Standards), Part 12 (Stabilization of Waste Retention Systems) (Tr. 1084), 3-300.J. (Land Ownership) and proposed new requirements for Surety (3-315) and Long Term Surveillance (12-300.E.).

As submitted to the Board Criterion 6 imposes three basic requirements that must be met concerning cover material to be placed over tailings at the time of final stabilization and reclamation. These are (1) a calculated reduction in surface emanation of radon from tailings or wastes to less than 2 pCi/m^2-sec, (2) reduction of direct gamma radiation exposure to background levels, and (3) a minimum thickness of three meters of earth cover.

While the Division finds that the 2 pCi/m^2- sec and minimum three meter cover criteria may in certain cases to be useful benchmark values for guidance in evaluating proposed reclamation programs it does not, for reasons summarized below, support the use of these specific values as regulatory requirements. Based on the evidence and supporting exhibits, the Division notes a number of problems with the proposed criterion including:

(1) The required radon flux limits are based on highly uncertain and speculative estimates of health effects (Tr. 91, 93, 143, 371, 476, 480, 958, 999) and on unfounded assumptions that

adverse health effects might occur in certain hypothetical situations (e.g. building and living in a home, with basement on a tailings pile (Tr. 93,139,1001,1021).

(2) The radon limits are not correlated with existing standards for radon control (Tr. 415).

(3) The criterion assumes a scenario of no government control(Tr. 365),notwithstanding the existence of requirements for the transfer of ownership of land and tailings to the State or Federal government, and proposed requirements for long-term surveillance.

(4) The specific fixed numbers used in the criterion do not provide for flexibility for site specific characteristics in administration, and thus discourage innovative approaches to reclamation and radon control.

(5) Determination of cover thickness for radon emanation control is based on complex mathematical models that have not to date been subjected to sensitivity analyses. In addition, certain of the critical parameters entering the models are based on limited experimental data.

(6) The NRC criterion recognizes but ineffect ignores experimental data that indicate that with proper installation and use of earth and rock materials (Tr. 856) the proposed three meter cover might be reduced by a factor of two (that is,from three to one ane one/half meters for effective reduction in radon emanation). Additional and promising studies, supported by the NRC and DOE are continuing (Tr. 643).

where $J_a = C_{Ra} \cdot \rho \cdot E \cdot \sqrt{\lambda \cdot D_t/P_t}$

so that $x = -\sqrt{(D_a/P)/\lambda} \cdot \ln\left[J/C_{Ra} \cdot \rho \cdot E \cdot \sqrt{\lambda \cdot D_t/P_t}\right.$

By Criterion 6, J = 2 pCi/m^2 - sec. (regulatory requirement)

λ is known to be = 2.1 x 10 sec^{-1} (radon decay constant) Therefore, estimates are required for:

C_{Ra}	=	conc. of radium in tailings solids (pCi/g)
ρ	=	density of the tailings solids (g/cm^3)
E	=	emanating "power" of the tailings (dimensionless)
D_t	=	effective bulk diffusion coefficient for radon from the tailings solids (cm^2/sec)
P_t	=	porosity of tailings soilds (dimensionless)
D_a	=	"alternate" diffusion coefficient of cover material (cm^2/sec)
P	=	porosity of the cover material (dimensiouless)

For the Gulf case the following estimates of the parameters were used:

C_{Ra}	=	1330 pCi/g
ρ	=	1.6 g/cm^3
E	=	0.2 (dimensionless)
D_t/P_t	=	0.0131 cm^2/sec
D_a/P	=	0.0131 cm^2/sec

In this simplified model, the ratios D/P (diffusion coefficient to porosity) were estimated from the empirical relation

$$D/P = 0.106 \exp(-0.261\ M)$$

where M is the moisture in percent. An assumed moisture content of 8% was used for both the tailings and cover material along with the further assumption that no depth adjustment is necessary so that $D_x/P \simeq D_e/P$ where D_e is the "exact" diffusion coefficient. The latter assumption can be used for thick covers. Using the indicated values, the final result of the computation was that the required cover thickness = 4.6 meters (15.2 feet).

Due to the planned use by Gulf of below grade disposal of tailings in deep trenches, approximately 50 feet of cover will be available and thus the computation readily indicates that radon control would not present a problem for ultimate reclamation of the tailings disposal area. However, for situations where earth cover is not readily available in sufficient quantity (e.g. existing surface impoundments), the calculated value of 4.6 meters, by Criterion 6, would constitute a regulatory, or legal, requirement.

The Division recognizes that in such a situation further refinements in the computation could and would be made (Tr.112). Unfortunately, such refinements would not necessarily improve the results due to the uncertainty involved in the estimates of the input parameters (Tr. 315). Sensitivity analyses by the Division, using the Gulf data noted above, indicated that the calculated value of 4.6 meters could easily vary from as low as 2.5 meters to as much as 6.7 meters, with the largest variation due to uncertainty in the estimate for the moisture content of the cover material. A variation in moisture content of the cover material of 2% results in a change in the calculated cover thickness of approximately 1 meter.

Given these uncertainties in the calculated results, which may or may not be resolved in any individual situation to the satisfaction of the agency, the licensee, and interested parties, Criterion 6 as proposed to the Board nevertheless requires a minimum thickness of 3 meters. The basis for this particular value is not entirely clear and in the Division's view the public hearing did not provide convincing arguments (Tr. 96,118) either for or against the 3 meter requirements. It is for this reason that the Division takes no position concerning whether the thickness should be less, equal to, or more than 3 meters. The required thickness, materials, and methods of emplacement should be based on a combination of measurements, calculations, evaluations, and scientific and engineering judgment. The proposed addition to 12.300.B, taken with the additional and complementary regulations noted earlier, allows such an approach and provides for:

(1) site specific and case by case determinations (Tr. 690,1103),

(2) flexibility in administration,

(3) primary emphasis on hydrologic, geologic, geomorphic, and related parameters (Tr. 89,479, 1009),

(4) encouragement of innovation (Tr. 643, 856),

(5) relationship to existing radiological health and reclamation standards (Tr. 560),

(6) recognition of government ownership (Tr. 880) and long-term surveillance; and

(7) the incontrovertible fact of the existence in New Mexico of very large and growing tailings piles (Tr. 226).

CRITERION 7

The Division recommends the deletion of this criterion as originally proposed, and the adoption of new language.

Criterion 7 - At least one full year prior to any major site construction, a preoperational monitoring program shall be conducted to provide complete baseline data on a milling site and its environs. Throughout the construction and operating phases of the mill, an operational monitoring program shall be conducted to measure or evaluate compliance with applicable standards and regulations; to evaluate performance of control systems and procedures; to evaluate environmental impacts of operation; and to detect potential long term effects.

DELETED

EID REVISED PROPOSALS-AUGUST 5, 1981

The EID recommends that Criterion 7, as submitted to the EIB, be deleted and written as an addition to the existing regulations as new 3-300.0.

RECOMMENDATION:

3-300.0 Up to one full year prior to licensing, a pre-operational monitoring and reporting program shall be developed and implemented which will provide baseline data on a uranium processing facility site and its environs. Throughout the construction and operating phases of the site, an operational and reporting program shall be conducted to measure or evaluate compliance with applicable standards and regulations, performance of control systems and procedures, environmental impacts of operation and to detect potential long-term effects.

BASIS FOR RECOMMENTATION:

Criterion 7 requires a preoperational and operational monitoring program. New Mexico Radiation Regulations currently do not have such a requirement and the Division favors this adoption. The Division has required the preoperational and operational monitoring program as part of the licensing actions and agrees with the necessity for the requirements outlined in Criterion 7, but prefers that the requirements be incorporated into present regulations.

No objections were expressed to the requirements of Criterion 7 at the hearing (Tr. 860-861, 899). Generally, all parties agree with the need for baseline data and continued monitoring in order to document and verify changes to the environment which may have occured as a result of the mill operation over the years. Operational monitoring is an acceptable standard industry policy.

CRITERION 8

The Division recommends the deletion of this criterion as originally proposed, and the adoption of new language.

Criterion 8 - Milling operations shall be conducted so that all air-borne effluent releases are reduced to levels as low as is reasonably achievable. The primary means of accomplishing this shall be by means of emission controls. Institutional controls, such as extending the site boundary and exclusion area, may be employed to ensure that offsite exposure limits are met, but only after all practicable measures have been taken to control emissions at the source. Notwithstanding the existence of individual dose standards, strict control of emissions is necessary to assure that population exposures are reduced to the maximum extent reasonably achievable and to avoid site contamination. The greatest potential sources of offsite radiation exposure (aside from radon exposure) are dusting from dry surfaces of the tailings disposal area not covered by tailings solution and emissions from yellowcake drying and packaging operations.

Checks shall be made and logged hourly of all parameters (e.g., differential pressures and scrubber water flow rates) which determine the efficiency of yellowcake stack emission control equipment operation. It shall be determined whether or not conditions are

DELETE

within a range prescribed to ensure that the equipment is operating consistently near peak efficiency; corrective action shall be taken when performance is outside of prescribed ranges. Effluent control devices shall be operative at all times during drying and packaging operations and whenever air is exhausting from the yellowcake stack. Drying and packaging operations shall terminate when controls are inoperative. When checks indicate the equipment is not operating within the range prescribed for peak efficiency, actions shall be taken to restore parameters to the prescribed range. When this cannot be done without shutdown and repairs, drying and packaging operations shall cease as soon as practicable. Operations may not be re-started after cessation due to off-normal performance until needed corrective actions have been identified and implemented. All such cessations, corrective actions, and re-starts shall be reported to the Division in writing within ten days of the subsequent re-start.

To control dusting from tailings, that portion not covered by standing liquids shall be wetted or chemically stabilized to prevent or minimize blowing and dusting to the maximum extent reasonably achievable. This requirement may be relaxed if tailings are effectively sheltered from wind, such as may be the case where they are disposed of below grade and the tailings surface is not exposed to wind. Consideration shall be given in planning tailings disposal programs to methods which would allow phased covering and reclamation of tailings impoundments since this will help in controlling particulate and radon emissions during operation.

Deleted

~~To control dusting from diffuse sources, such as tailings and ore pads where automatic controls do not apply, operators shall develop written operating procedures specifying the methods of control which will be utilized.~~

DELETED

EID REVISED PROPOSALS-AUGUST 5, 1981

The EID recommends that Criterion 8, as submitted to the EIB, be deleted and that the following be added to the existing regulations as 4-160.G.

RECOMMENDATION:

4-160G. Uranium processing operations shall be conducted so that all air-borne effluent releases are reduced to at least the standards in Part 4, New Mexico Radiation Protection Regulations and to levels as low as are reasonably achievable. The primary means of accomplishing this shall be by emission controls. Institutional controls such as extending the site boundary and exclusion area, may be employed to ensure that offsite exposure limits are met, but only after all practicable measures have been taken to control emissions at the source. The licensee shall prepare and submit to the Division for approval plant operating procedures for yellowcake drying and packaging operations and yellowcake stack emissions control equipment describing procedures for assuring that emissions will be within New Mexico standards. Operating procedures for interim stabilization of tailings not covered by liquid or otherwise protected from wind dispersion must also be included and approved by the Division.

BASIS FOR RECOMMENDATION:

The EID recommends that the licensee or applicant submit to the Division for approval engineering plans and operating procedures for meeting emission standards and assuring that those standards would be continuously met. This allows the applicant to design emission controls which consider advances in technology in the reduction of releases to levels as low as reasonably achievable. No objections were expressed to the requirements of Criterion 8 at the hearing and it is generally supported (Tr. 862-865, 899-901). The essential elements of the original proposal have been retained, with the deletion of nonessential language.

CRITERION 8A

The Division recommends the deletion of this criterion as originally proposed, and the adoption of new language.

EID PROPOSALS DATED MAY 8, 1981

Criterion 8A - At least daily inspections of tailings or waste retention systems shall be conducted by a qualified engineer, scientist, or management representative acceptable to the Division and documented. The Division shall be immediately notified of any failure in a tailings or waste retention system which results in a release of tailings or waste into unrestricted areas, and/or of any unusual conditions (conditions not contemplated in the design of the retention system) which, if not corrected, could indicate the potential or lead to failure of the system and result in a release of tailings or waste into unrestricted areas (see 4-420, Notification of Accidents).

DELETED

EID REVISED PROPOSALS-AUGUST 5, 1981

The EID recommends that Criterion 8A, as submitted to the EIB, be deleted and the following be added to the existing regulations as new 3-300.P and 4-420.D.

RECOMMENDATIONS:

3-300P. Uranium processing facility applicants shall develop a tailings management plan and provide for inspections of tailings or waste retention systems at least daily by a qualified engineer, scientist or management representative. Incidents must be reported to the Division in accordance with 4-420D.

4-420D. The Division shall be immediately notified of any failure in a tailings or waste retention system which results in a release of tailings or waste into unrestricted areas, or of unexpected conditions not contemplated in the system design which could lead to failure of the system and result in a release of tailings or waste into unrestricted areas.

BASIS FOR RECOMMENDATIONS:

The EID agrees with the requirements of Criterion 8A as important in the regulation of uranium tailings management. The uranium industry did not object to these requirements at the hearing, and generally recognizes them as part of responsible management. (Tr. 865-866). The essential elements of the original proposal have been retained, with the deletion of nonessential language.

CRITERION 9

The Division recommends the deletion of this criterion as originally proposed, and the adoption of new language.

II. Financial Criteria

Criterion 9 - Financial surety arrangements shall be established by each mill operator prior to the commencement of operations to assure that sufficient funds will be available to carry out the decontamination and decommissioning of the mill and site and for the reclamation of any tailings or waste disposal areas. The amount of funds to be ensured by such surety arrangements shall be based on approved cost estimates in a Division approved plan for (1) decontamination and decommissioning of mill buildings and the milling site to levels which would allow unrestricted use of these areas upon decommissioning, and (2) the reclamation of tailings and/or waste disposal areas in accordance with criteria delineated in Section I; Technical Criteria, of this Appendix, and (3) long-term surveillance and control The licensee shall submit this plan in conjunction with an environmental report (3-300.H.) that addresses the expected environmental impact of the milling operation, decommissioning and tailings reclamation, and evaluates alternatives for mitigating these impacts. In establishing specific surety arrangements, the licensee's cost estimates shall take into account total costs that would be incurred if an independent contractor were hired to perform the decommissioning and reclamation work. In order to avoid unnecessary duplication and expense, the Division may accept financial sureties that have been consolidated with financial or surety arrangements established to meet requirements of other federal or state agencies and/or local governing bodies for such decommissioning, decontamination, reclamation, and long term site surveillance and control, provided such arrangements are considered adequate to satisfy these requirements and that the portion of the surety which covers the decommissioning and reclamation of the mill, mill tailings site and associated areas, and the long term funding charge is clearly identified and committed for use in accomplishing these activities. The licensee's surety mechanism will be reviewed annually by the Division to assure that sufficient funds would be available for completion of the reclamation plan if the work had to be performed by an independent contractor. The amount of surety liability should be adjusted to recognize any increases or decreases resulting from inflation, changes in engineering plans, activities performed, and any other conditions affecting costs. Regardless of whether reclamation is phased through the life of the operation or takes place at the end of operations, an appropriate portion of surety liability shall be retained until final compliance with the reclamation plan is determined. This will yield a surety that is at least sufficient at all times to cover the costs of decommissioning and reclamation of the areas that are expected to be disturbed before the next license renewal. The term of the surety mechanism mus be open ended, unless it can be demonstrated that another arrangement would provide an equivalent level of assurance. This assurance could be provided with a surety instrument which is written for a specified period of time (e.g., five years) yet which must be automatically renewed unless the surety notifies the beneficiary (the Division or the appropriate State agency) and the principal (the licensee) some reasonable time (e.g., 90 days) prior to the renewal date of their intention not to renew. In such a situation the surety requirement still exists and the licensee would be required to submit an acceptable replacement surety within a brief period of time to allow at least 60 days for the regulatory agency to collect.

DELETED

Proof of forfeiture must not be necessary to collect the surety so that in the event that the licensee could not provide an acceptable replacement surety within the required time, the surety shall be automatically collected prior to its expiration. The conditions described above would have to be clearly stated on any surety instrument which is not open-ended, and must be agreed to by all parties. Financial surety arrangements generally acceptable to the Division are:

(a) Surety bonds;

(b) Cash deposits:

(c) Certificates of deposit;

(d) Deposits of government securities;

(e) Irrevocable letters or lines of credit; and

(f) Combinations of the above or such other types of arrangements as may be approved by the Division.

However, self insurance, or any arrangement which essentially constitutes self insurance (e.g., a contract with a state or federal agency), will not satisfy the surety requirement since this provides no additional assurance other than that which already exists through license requirements.

DELETED

Release of surety requirements shall be accomplished when the Division determines that all license conditions are satisfied.

EID REVISED PROPOSALS-AUGUST 5, 1981

The Division recommends the following surety provision be adopted as new 3-315:

RECOMMENDATION:

3-315A. Surety arrangements shall be established by uranium processing applicants and licensees to assure that sufficient funds will be available for reclamation (decommissioning and decontamination of the facility and reclamation of the waste disposal area) as required by the license and the regulations. The amount of the surety shall be based on cost estimates of hiring an independent contractor to perform the reclamation. The surety shall be adjusted annually to reflect changes in costs resulting from inflation, revised plans, and any other condition affecting costs. Regardless of whether reclamation is phased through the life of the operation or takes place at the end of operations, an adequate portion of surety shall be retained until final compliance with the reclamation plan is determined by the Division. The surety shall be released upon demonstration by the licensee that an approved reclamation plan has been implemented as required by the license and the regulations.

B. The surety shall be provided by any applicant for a new or renewed license prior to issuance of the license, and by any licensee within 180 days of the effective date of this regulation.

C. Acceptable surety arrangements must be negotiable in New Mexico and include:

1. a bond running to the State issued by a fidelity or surety company;
2. irrevocable assignment to the State of savings or certificate of deposit;

3. a cash bond posted with the State by the licensee;

4. an irrevocable letter of credit or line of credit to the State issued by a recognized financial institution;

5. self insurance based on licensee assets legally secured to the State;

6. combinations of the above or other arrangements acceptable to the Division.

BASIS FOR RECOMMENTATION:

The Division considers that surety requirements are essential to protect the State from the risk of paying reclamation costs for uranium tailings in the event of abandonment by present operators. This is consistent with the Radiation Protection Act (Section 74-3-5-A.(III) NMSA 1978) which empowers the EIB to promulgate regulations "requiring the posting of a bond running to the state...adequate to insure, in the event of abandonment, default or other performance inabilities of the licensee, compliance with the...regulations or license conditions, including actions of the licensee required during or after cessation of operations".

It is common practice for the State to require a form of surety for activities which may affect the public health and safety and the environment. An example is the New Mexico Department of Energy and Minerals which requires surety arrangements for the reclamation of surface coal mining activities. That regulation is similar, but more detailed than the one under consideration, and has been adopted without objection from the coal industry. It allows self insurance as an option. The State of Texas has proposed a similar surety regulation for uranium facility reclamation which does not prohibit self insurance.

The Division has included self insurance as one of the acceptable surety options and has defined the term so that financially stable companies may use their assets as surety. Because unsecured assets have no value to the State, it is necessary to specify that self insurance be "based on licensee assets legally secured to the State". In the event of bankruptcy, it is probable that assets not specifically secured to the State would go to other secured companies or government agencies.

A persuasive argument for the adoption of a surety regulation is the example of the Grace Nuclear Corporation which has abandoned three facilities without reclamation. The Division is currently involved in preparing for a legal action with the Corporation, but without surety arrangements the State may finally be required to use public funds for reclamation necessary to protect the public health and Safety.

It is important to note that the surety recommendation leaves five options, or combinations of options, open to the operator, including self insurance. Other types of surety arrangements may also be proposed by the applicant or licensee. It would not be necessary to purchase a bond from a surety company if one of the other options is more satisfactory.

CRITERION 10

The Division recommends the deletion of this criterion as originally proposed, and the addition of new language to an existing regulation.

This criterion was supported at the hearing (Tr. 867, 901-02). There was substantial discussion regarding the feasibility of obtaining surety bonds, the cost of obtaining letters of credit, and the suitability and definition of self insurance (Tr. 869-72, 154-1208). Based on the testimony of the uranium industry, ıblic interest groups and the NRC, the Division recommends that self insurance, along with other options proposed by the applicant or licensee be included as an acceptable option.

III. Long Term Site Surveillance

Criterion 10 - The final disposition of tailings or wastes at milling sites shall be in accordance with Parts 1, 3, 4 and 12 of these regulations and directed to the long term goal such that ongoing active maintenance is not necessary to preserve isolation. As a minimum, annual site inspections shall be conducted by the Division or State agency retaining ultimate custody of the site where tailings, or wastes are stored to confirm the integrity of the stabilized tailings or waste systems and to determine the need, if any, for maintenance and/or monitoring. Results of the inspection shall be reported to the Division within sixty days following each inspection. The Division may require more frequent site inspections if, on the basis of a site-specific evaluation, such a need appears necessary due to the features of a particular tailings or waste disposal system.

DELETED

EID REVISED PROPOSALS-AUGUST 5, 1981

The EID recommends that following language changes be made to 12-300.E. of existing regulations.

RECOMMENDATION:

12-300.E. Stabilized inactive waste retention systems shall be inspected by the licensee ~~(regularly)~~ at least annually to assure continued integrity of the stabilization system and also immediately following any natural or man-made occurrences, which would affect the integrity of the stablization. Maintenance needed to restore the system to their original effectiveness shall be performed as soon as possible. Inspections shall include surveys to determine evironmental concentrations of radioactive materials. Such inspections and maintenance shall be performed by the licensee until the Division has determined that the licensees' stabilization program has been implemented in accordance with license conditions and applicable regulations and the license is terminated by the Division and the licensee is formally notified of such termination by certified mail. If transfer of the property to the State occurs in accordance with 3-300.J., the Division will continue to inspect annually and maintain the waste retention system as necessary.

BASIS FOR RECOMMENDATION:

This criterion requires annual inspection and monitoring of stabilized waste retention systems by State or Federal agencies after transfer of the property from the former licensee. Part

12-300.E. of current New Mexico Radiation Regulations refers to inspections and monitoring by the licensee as owner of the property pending final acceptance of the stabilization program by the State and the legal transfer of the property to the State or a Federal Agency.

The recommended deletion of Criterion 10 and change to 12-300.E. will provide for continuous inspection and monitoring from the time of tailings stabilization into the distant future regardless of who owns the property. The suggested changes should meet all the requirements of both the current 12-300.E. and Criterion 10. These requirements are generally supported by all parties (Tr. 867-868, 902).

CRITERION 11

The Division recommends that further action on this criterion be deferred pending a decision by the New Mexico Supreme Court.

IV. Site and Byproduct Material Ownership

Criterion 11-A. These criteria relating to ownership of tailings and their disposal sites become effective on November 8, 1981, and apply to all licenses terminated, issued, or renewed after that date.

B Any uranium or thorium milling license or tailing license shall contain such terms and conditions as the Division determines necessary to assure that prior to termination of the license, the licensee will comply with ownership requirements of this criterion for sites used for tailings disposal.

C. Title to the byproduct material licensed under this Part and land, including any interests therein (other than land owned by the United States or by the State of New Mexico) which is used for the disposal of any such byproduct material, or is esstential to ensure the long term stability of such disposal site, shall be transferred to the United States or the State of New Mexico, at the option of the State. In view of the fact that physical isolation must be the primary means of long term control, and Government land ownership is a desirable supplementary measure, ownership of certain severable subsurface interests (for example, mineral rights) may be determined to be unnecessary to protect the public health and safety and the environment. In any case, however, the applicant/ operator must demonstrate a serious effort to obtain such subsurface rights, and must in the event that certain rights cannot be obtained, provide notification in local public land records of the fact that the land is being used for the disposal of radioactive material and is subject to either a State or Nuclear Regulatory Commission general or specific license prohibiting the disruption and distrubance of the tailings. In some rare cases, such as may occur with deep burial where no ongoing site surveillance will be required, surface land ownership transfer requirements may be waived. For licenses issued before November 8, 1981, the Division may take into account the status of the ownership of such land, and interests therein, and the ability of a licensee to transfer title and custody thereof to the United States or the State.

D. If the Nuclear Regulatory Commission, subsequent to title transfer, determines that use of the surface or subsurface estates, or both, of the land transferred to the United States or to the State will not endanger the public health, safety, welfare, or environment the Commission may permit the use of the surface or subsurface estate, or both of such land in a manner consistent with the provisions provided in these criteria. If the Commission permits such use of such land, it will provide the person who tranferred such land with the right of first refusal with respect to such use of such land.

E. Material and land transferred to the United States or the State in accordance with this Criterion shall be transferred without cost to the United States or the State other than adminstrative and legal costs incurred in carrying out such transfer.

F. The provisions of this Part respecting transfer of title and custody to land and tailings and wastes shall not apply in the case of lands held in trust by the United States for any Indian tribe or lands owned by such Indian tribe subject to a restriction against alienation imposed by the United States. In the case of such lands which are used for the disposal of byproduct material, as defined by the Nuclear Regulatory Commission, the licensee shall enter into arrangements with the Commission as may be appropriate to assure the long term surveillance of such lands by the United States.

Criterion 11 deals with the land ownership and transfer requirements found in Section 202 of the Uranium Mill Tailings Radiation Control Act of 1978. On April 11, 1980, Radiation Protection Regulation 3-300J. was adopted by the Environmental Improvement Board. 3-300J. in most regards addresses the same concerns as Criteria 11. 3-300J. was filed with the State Records Center on April 21, 1980 and became effective on May 21, 1980. Several uranium companies appealed this Regulation to the Court of Appeals, which found that 3-300J. was improperly adopted. The Environmental Improvement Board then filed a Writ of Certiorari with the New Mexico Supreme Court. The writ was granted and at this time the validity of 3-300J. is being deliberated by the New Mexico Supreme Court. Pending the outcome of the Supreme Court's deliberations, 3-300J. remains in effect. The regulation has not been stayed by either the Court of Appeals or the Supreme Court.

It is therefore recommended that the Board take no action at this time on the property ownership requirements of Criterion 11. After the Supreme Court decides on the validity of 3-300J., the Board could reopen the hearing record only for the purpose of taking final comments and suggestions on 3-300J. Those final comments may well differ depending on the Supreme Court's decision. Then the Board could act considering the record made at the June 11-13, 1981 public hearing, the written comments submitted after the public hearing, and the ruling of the Supreme Court.

DEFINITIONS

The Division recommends that these definitions be deleted.

Attachment 3

DELETED

(g) A "capable fault" is a fault which has exhibited one or more of the following characteristics:

(1) Movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years.

(2) Macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.

(3) A structural relationship to a capable fault according to characteristics (1) or (2) of this paragraph such that movement on one could be reasonably expected to be accompanied by movement on the other.

In some cases, the geologic evidence of past activity at or near the ground surface along a particular fault may be obscured at a particular site. This might occur, for example, at a site having a deep overburden. For these cases, evidence may exist elsewhere along the fault from which an evaluation of its characteristics in the vicinity of the site can be reasonably based. Such evidence shall be used in determining whether the fault is a capable fault within this definition.

Testimony before

the

Subcommittee on Procurement and

Military Nuclear Systems

Committee on Armed Services

House of Representatives

by

Warren K. Sinclair

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My name is Warren Keith Sinclair. I reside at 2900 Ascott Lane, Olney, Maryland and I have a Ph.D. in Physics and background in biophysics and radiobiology. I am presently employed full-time as the President of the National Council on Radiation Protection and Measurements (NCRP) on whose behalf I am appearing today, although neither my Board nor the Council itself have approved this testimony. I am on leave from my position of Senior Biophysicist at Argonne National Laboratory where I was also, until recently, Associate Laboratory Director for Biomedical and Environmental Research and from my position as Professor of Radiation Biology at the University of Chicago, positions which I have held for 22 years. My personal experience in research has included a variety of studies in medical physics with both radionuclides and beam radiation, in biophysics and radiobiology on both animal and cellular aspects of radiation effects, and in radiation protection and human risk estimation and I have published over 120 original articles on my research.

I should also say that I am a member of the International Commission on Radiation Units and Measurements, a member of the International Commission on Radiological Protection, and a member of the U.S. Delegation to the United Nations Scientific Committee on the Effects of Atomic Radiation and I have made many contributions to the reports of these bodies as well as to reports of the NCRP.

I would like to present to you some information about the NCRP. The NCRP began in 1929, first as an advisory committee on x ray and radium protection, later as a National Committee on Radiation Protection and finally, since 1964, as the National Council on Radiation Protection and Measurements, a not for profit corporation chartered by the Congress of the United States, "to collect, analyze, develop, and disseminate in the public interest information and recommendations about (a) radiation protection, and (b) radiation measurements, quantities, and units, particularly those concerned with radiation protection. There are, of course, additional clauses.

The Council currently consists of 75 members, all experts in their field, and embracing a wide range of disciplines in science and engineering and including specialists in nonionizing as well as ionizing radiation. In addition there are about 400 additional scientists involved in the work of the 70 or so committees and task groups that are presently active in the NCRP. These persons serve voluntarily, motivated by their interest in the field and a spirit of public service. The organization is supported by almost 40 collaborating organizations, scientific and medical societies as well as various branches of the federal government and the armed services.

The NCRP produces scientific reports on a wide variety of topics that relate to radiation protection, including, for example, radiobiology - like report 64 - I, (1) assessment of dose to-the public, like from natural background report 45 - II, (2) guidance - as for example in environmental measurement - report 50 - III, (3) on information as for example, report 44 on krypton-85 - IV, (4) and its corollary, a report on krypton-85 venting at Three Mile Island - V, (5) and lastly, for the present, on nonionizing radiation - microwaves - report 67 - VI (6). (See Report Covers)

These reports are produced initially by a drafting committee of experts appointed by the Board of the NCRP and then reviewed critically by other Council experts and finally by all 75 members of the Council. We hope they represent the best that experts can do at any given time.

Basis for Radiation Protection Standards

The first radiation protection recommendations were made about fifty years ago by NCRP to protect workers in the medical applications of x rays and radium (7). The predecessors of the NCRP, using the principle of absence of observable harm, set the level at about 1/10th of an erythema dose per year (actually 1/100th of an erythem dose per month) which resulted in a "tolerance" dose of 0.1R/day [Figure 1]. In 1949, as the result of the development of atomic energy during World War II and the realization that radiation work would expand to many fields other than medicine, levels were reduced by a factor of about 2 to 0.3 rem/wk, 15 rems/yr. Not long afterward, a further reduction of a factor of 3 in occupational levels was introduced, again, not because of observed harm, but because of concern about genetic effects and the assumption of linearity for prudence (8). Public levels were introduced for the first time. In 1971 the occupational levels were not altered but public levels were modified to 0.5 rem/yr to the individual and 0.17 rem/yr as an average. ICRP has had a parallel set of recommendations, their last report in 1977 recommending 5 rems/yr occupational and 0.5 rem to an individual in the public; they expected the latter to result in no more than a 1/10th or 0.05 rem on the average to the public (in addition to background and medical) (7).

Thus, the actual doses associated with recommended levels for the public and for radiation workers have not altered greatly in the past two decades. What has changed is the scientific appreciation of the hazards of radiation at low levels. All the non stochastic effects of radiation, which have thresholds, such as impaired fertility, cataract and damage to the blood forming organs etc. are no longer important at low doses. The important problems at low doses are the risk of cancer induction and the risk of genetic (hereditary) effects both believed to be stochastic, i.e. occurring with a certain probability even down to the lowest doses. In the last decade in particular the quantification of these risks has become increasingly important in relation to the other risks the public and workers generally face in their daily lives.

Calculation of Radiation Risks

The United Nations Scientific Committee (UNSCEAR) in 1972 (9), and again in 1977 (10), the BEIR Committee of the National Academy of Sciences (USA) in 1972 (11) and 1977 (12) and the International Commission on Radiological Protection in 1977 (13) have made detailed estimates of the risk of cancer and genetic effects. In the case of cancer induction, the risks are derived from the study of effects in human populations exposed to ionizing radiation for which an estimate of the dose is possible and the effects can be distinguished from those occurring naturally in the population. These populations include those shown in Figure 2 (14).

In the case of genetic effects, estimates of human effects are derived from animal data, principally the mouse, but human effects are known to be not more severe relatively than those in animals because of the comparative absence of genetic effects in the Japanese populations exposed to atomic bombs.

There are, of course, limitations on the data bases available from which these estimates are made. These limitations include:

- uncertainties in the estimates of dose,
- the difficulty of distinguishing between the excess induced cancers and those occurring naturally,
- the difficulties of extrapolating from the higher doses where data is available to the lower doses where information is required,
- uncertainties about the choice of risk model, relative or absolute;
- uncertainties concerning incidence vs mortality and, of course,
- the confounding factors of sex and age dependence of tumor induction.

To reduce the measure of uncertainty all these factors contribute, the scientific community continues to sift, examine, and explore new information as it develops, for example the continuing accumulation of data in the Japanese population which will go on well beyond the year 2000, information from new populations irradiated therapeutically and now surviving for long periods, and improvements in dose estimations in the Japanese and other populations. More and more information will steadily either improve our confidence in the current estimates of risk or modify the values, at least to some degree. Nevertheless, five different groups over the past decade have come to remarkably similar conclusions concerning the risk. A brief comparison of BEIR (1980) and UNSCEAR (1977) estimates is shown in Figure 3.

Probably a reasonable synthesis of current estimates is that the total absolute risk of fatal cancer and genetic effects is about $(1-2) \times 10^{-4}$ per rad lifetime, and the more important cancers such as leukemia, breast, thyroid, and lung each contribute about $(2-5) \times 10^{-5}$ per rad lifetime. Note that some, notably the BEIR Committee of 1980, did not consider these risk estimates applicable below 10 rad and 1 rad/year. Others tend to use them, appreciating that at the lower doses a linear extrapolation from 10 rads to lower doses may yield estimates for x and γ rays that are high rather than low.

Risk in Context

The estimation of radiation risks must be compared with other known risks in order to be meaningful.

Occupational:

One method of comparison occupationally is to examine the risk rates in existing occupations. A direct way is to compare with industries in which the main risk is also that of getting cancer. However, the risks in such industries as those involving benzene, arsenic, asbestos, petroleum products, nickel, chromium, etc. turn out to be rather high, of the order of 10^{-3}/year to 10^{-2}/year (15). Perhaps more reasonable is to compare with other industries in which occupational accidents are the main causes of death. The data of the National Safety Council (Figure 4) indicate that safer industries have accident rates below 10^{-4}/year while common but less safe industries approach 10^{-3}/year (mining, construction) (16). Others may even reach 10^{-2}/year e.g. smoke stack construction, deep sea fishing, navy frogmen, etc. (17) Test pilots may have even higher risks and so do astronauts on some missions.

Radiation risks at average occupational levels (less than 0.5 rem/yr) eventually reach about 0.5×10^{-4}/yr. or less and are thus comparable with many of the safer "safe" industries.

Public

There is no such thing as "zero" risk in our society and there never has been. Some risks, especially those we understand well and derive pleasure from (e.g. sporting activities) we accept without question while others, often less in magnitude, but less well understood and for which the benefits to the individual are less evident, are less widely accepted. Nevertheless, many risks to average members of the public fall in the range of 10^{-5} to 10^{-6}. One in a million risk of death, 10^{-6}, is a rather small risk. A table from a British worker, E. Pochin, yields some examples, Figure 5. (18)

Risks ten times greater than one in a million or 10^{-5}, can be seen by multiplying the numbers in the table by 10, i.e. 4000 miles by air or 600 miles by car yield a risk of 10^{-5}. Many common medications also carry risks of 10^{-5} or greater and are regularly or commonly experienced by most people.

The risk eventually associated with the maximum dose permitted to a member of the public namely 0.5 rem/yr is comparable with the risk experienced by the average occupational worker, about 0.5×10^{-4}/year or 3×10^{-3} lifetime, similar to those from rather safe occupations. However the average exposure expected to the public by ICRP, about 1/10th the maximum, or 0.05 rem/yr (which is only half the background radiation level excluding radon) accumulates to a risk of only about 0.5×10^{-5}/yr or 3×10^{-4} lifetime comparable or less than many other common risks.

Note: Risk associated with background (a) at 0.1 rem/yr due to terrestrial, cosmic and internal sources are about 700 per million (see Figure 3, UNSCEAR) (b) Radon, average U.S. background level, 0.004 WL, leads to lung cancer risk of $40/10^6$/year (Harley). This is to be multipled by a period at risk of ~ 40 years which yields ~ 1600 per million or perhaps one to two times the risks associated with other sources of background.

Common Radiation Exposures

Occupational:

In the United States some 1.2 million people are engaged in work which brings them into contact with radiation. Some figures on the average exposure of these workers extracted from the BEIR report follow, Figure 6 . An overall average is about 250 mrem or only 2 ½ times the natural background excluding radon.

Public exposures include those from a variety of sources listed in (Figure 7). Note that air travel because of the increased cosmic radiation at high altitudes contributes a small but calculable amount to the average public exposure. To individuals like myself travelling 100,000 miles or more in a year air travel contributes an additional 50 to 100 mrems each year, or a significant multiplication of the background rate, perhaps up to twice. Thus, the expected dose from background in a lifetime could be increased from about 7 rems to about 10 or 14 rems because of air travel.

Hazards from the Mill Tailings

The hazards from the mill tailings include (a) radon emanation into the air from the piles, (b) γ radiation issuing from the body of the piles and (c) leakage of radioactive materials from the piles which might be ingested from water or food.

Radon

The total amount of radon released into the air from the ground (USA) is 120 million Ci of radon, the mill tailings and mines contribute 350,000 Ci (19) or 0.2%, only a small increment to the general exposure of the U.S. population and well within the error of the estimates. Using the ALARA principle, exposure of individuals should not exceed background if at all possible; the background being 0.004 WL of radon. John Harley testified earlier (20) that his NCRP Committee recommends that action should be taken at enhanced levels 5 times background or more, i.e. 0.02 WL (including background, i.e. 0.016 additional). A British recommendation would accept 0.01 WL additional background before action is to be considered and 0.05 WL additional to background before action is mandatory (21). These recommendations indicate that if a small number of individuals were to exceed the average background in the range of 2 to 12 times, these committees would not consider this a serious population exposure problem.

External Exposure

Background is about 0.1 rem/yr, and current (22) NCRP and ICRP (10) recommendations permit 0.5 rem/yr in addition, to the maximum individual (a small number of individuals in a group). Thus, while again ALARA would suggest that individuals be exposed to no more than background exposure, if small groups were exposed to 5 x this level this would not be considered a serious exposure problem.

Leakage of Radioactive Material

Leakage of radioactive materials must be controlled in such a way that levels do not exceed those permitted in drinking water for members of the public. Public levels are usually a factor of 10 below those accepted occupationally. (23)

Summary

The NCRP has been developing radiation protection recommendations for more than 50 years in its efforts to provide guidance in all areas of radiation protection. Current recommendations are based both on experience and on estimates of the risk of cancer induction and genetic effects. Occupational exposures in the USA and the risks associated with them are less than or comparable with the risk in other "safe" industries. For the public, exposures and the risks associated with them are less than or comparable with many other risks frequently encountered in their daily lives.

Radiation exposures likely to result from mill tailings would seem to pose a negligible threat to the population as a whole and presumably the mill tailings can be controlled to avoid individual exposures beyond undesirable levels.

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Illustrations

Figure 1	82-42	NCRP protection recommendations 1934-71.
Figure 2	W80-17	List of populations used for risk estimation.
Figure 3	W81-3	Comparison of BEIR and UNSCEAR risk estimates.
Figure 4	82-14	Accident rates in various industries (NSC).
Figure 5	82-43	Table of risks of one in a million from Pochin.
Figure 6	W80-49	Average exposures in various occupations (BEIR 1980)
Figure 7	W80-50	Common exposures to the public (BEIR 1980)

Report Covers

Krypton-85 in the Atomosphere - With Specific Reference to the Public Health Significance of the Proposed Controlled Release at Three Mile Island

NCRP Report No. 44 - Krypton-85 in the Atmosphere, Accumulation, Biological Significance, and Control Technology

NCRP Report No. 45 - Natural Background Radiation in the United States

NCRP Report No. 50 - Environmental Radiation Measurements

NCRP Report No. 64 - Influence of Dose and Its Distribution in Time on Dose-Response Relationships for Low-LET Radiations

NCRP Report No. 67 - Radiofrequency Electromagnetic Fields Properties, Quantities and Units, Biophysical Interaction, and Measurements

NCRP Protection Recommendations

	Occupational Limit	Annual Equivalent	Public
1934	0.1R/day	~ 30R/year	
1949	0.3R/week	~ 15R/year	
1957	5(N-18) rem N = age	5rem/year	10rem/30year
1971	5(N-18) rem	5rem/year	0.5rem/year max. 0.17rem/year ave.

SOURCES OF HUMAN EXPOSURE INFORMATION

Japanese Survivors of A-Bombs

Marshall Islanders Exposed to Fallout

Pelvic Radiotherapy

Spinal Radiotherapy (Ankylosing Spondilitis)

Neck and Thyroid Radiotherapy

Scalp Irradiation (tinea capitis)

Breast Radiotherapy

Multiple Fluoroscopies

Uranium Miners

$Radium^{226}$ Ingestion

$Radium^{224}$ Treatment

COMPARISON OF CANCER DEATHS POTENTIALLY INDUCED BY UNSCEAR (1977) AND BEIR (1980)

	Number of Cancer Deaths per million			
	USA	BEIR III 1980		UNSCEAR 1977
Single Dose		Abs.	Rel.	
10 rads	163,800	766	2255	1000
Increase %		0.47%	1.4%	
Continuous Dose				
1 rad/yr lifetime	167,300	4751	12920	7000
Increase %		2.8%	7.7%	

Note: This is for LQ model
L-L model x (2-3)
Q-L model x ~1/10th or less

ACCIDENTAL DEATH RATE PER 100,000 WORKERS

<table>
<tr><th>Industry</th><th>1950</th><th>1955</th><th>1960</th><th>1965</th><th>1970</th><th>1975</th><th>1980</th><th>Mean</th><th>Approximate Change 1950-80 [%]</th></tr>
<tr><td>Trade</td><td>12</td><td>11</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>8.4</td><td>−50%</td></tr>
<tr><td>Manufacturing</td><td>16</td><td>13</td><td>10</td><td>10</td><td>9</td><td>8</td><td>8</td><td>10.6</td><td>−50%</td></tr>
<tr><td>Service</td><td>14</td><td>15</td><td>15</td><td rowspan="2">13</td><td>12</td><td>9</td><td>7</td><td>12.1</td><td>−50%</td></tr>
<tr><td>Government</td><td></td><td></td><td></td><td>13</td><td>12</td><td>11</td><td>13.3</td><td>−20%</td></tr>
<tr><td>Utilities</td><td>27</td><td>14</td><td rowspan="2">38</td><td rowspan="2">41</td><td rowspan="2">36</td><td rowspan="2">33</td><td rowspan="2">28</td><td rowspan="2">37.6</td><td rowspan="2">−35%</td></tr>
<tr><td>Transportation</td><td>43</td><td>44</td></tr>
<tr><td>Construction</td><td>93</td><td>76</td><td>73</td><td>73</td><td>72</td><td>61</td><td>45</td><td>70.4</td><td>−50%</td></tr>
<tr><td>Mining and Quarrying</td><td>110</td><td>104</td><td>123</td><td>108</td><td>100</td><td>63</td><td>50</td><td>94.0</td><td>−55%</td></tr>
<tr><td>Agriculture</td><td>57</td><td>55</td><td>58</td><td>65</td><td>67</td><td>58</td><td>61</td><td>60.2</td><td>+ 7%</td></tr>
<tr><td>ALL INDUSTRIES</td><td>27</td><td>24</td><td>22</td><td>20</td><td>18</td><td>15</td><td>13</td><td>19.9</td><td>−50%</td></tr>
</table>

Data is from the publications of the National Safety Council "Accident Facts" for the years indicated. Classifications have changed somewhat over this thirty year period.

A one in a million risk of death has been attributed to each of the following [16]:*

400 miles by air
60 miles by car
3/4 of a cigarette
1 1/2 minutes of rock climbing
1 1/2 weeks of typical (UK) factory work
20 minutes being a man aged 60

*Pochin, E.E. (1967). "Principles and practice of radiation protection," page 13 in Symposium on Radiation Dose Measurements, Stockholm, Sweden June 12-16, 1967 (European Nuclear Agency, Paris).

OCCUPATIONAL EXPOSURES

	Number of People	Average Exposure
Medical		
Diag. X rays - medical	195,000	300-350 mrems
Diag. X rays - dental	170,000	50-125 mrems
Radiopharmaceuticals	100,000	260-350 mrems
Nuclear Industry		
Power Plants	67,000	400 mrems
Industrial Radiography	11,250	320 mrems
Fuel Processing	11,250	160 mrems
By-product Material Handling	3,500	350 mrems
DOE Contractors	88,500	250 mrems
Naval Nuclear Propulsion	36,000	220 mrems
Research Activities		
Electron microscopes, etc.	4,400	50-200 mrems
Airline Crews	40,000	160 mrems

(BEIR 1980)

ANNUAL POPULATION EXPOSURE

Natural Background	84 mrem (65-125 mrem)
Medical Exposure	90 mrem
Fallout	4 mrem
Nuclear Power	<1 mrem
Research Activities	<1 mrem
Consumer Products (Building Materials)	3-4 mrem
Airline Travel	0.5 mrem
Airline Crews	160 mrem

(BEIR 1980)

KRYPTON-85 IN THE ATMOSPHERE—WITH SPECIFIC REFERENCE TO THE PUBLIC HEALTH SIGNIFICANCE OF THE PROPOSED CONTROLLED RELEASE AT THREE MILE ISLAND

May 16, 1980

NCRP

National Council on Radiation Protection and Measuremen

NCRP REPORT No. 44

KRYPTON-85 IN THE ATMOSPHERE— Accumulation, Biological Significance, and Control Technology

NCRP

National Council on Radiation Protection and Measurements

NCRP REPORT No. 45

NATURAL BACKGROUND RADIATION IN THE UNITED STATES

|N|C|R|P|

National Council on Radiation Protection and Measurements

NCRP REPORT No. 50

ENVIRONMENTAL RADIATION MEASUREMENTS

National Council on Radiation Protection and Measurements

NCRP REPORT No. 64

INFLUENCE OF DOSE AND ITS DISTRIBUTION IN TIME ON DOSE-RESPONSE RELATIONSHIPS FOR LOW-LET RADIATIONS

NCRP

National Council on Radiation Protection and Measurements

NCRP REPORT No. 67

RADIOFREQUENCY ELECTROMAGNETIC FIELDS

Properties, Quantities and Units, Biophysical Interaction, and Measurements

NCRP

National Council on Radiation Protection and Measurements

STATEMENT

CONCERNING

STABILIZATION AND MANAGEMENT

OF COMMINGLED

URANIUM MILL TAILINGS PILES

AUGUST 18, 1982

BEFORE

THE

SUBCOMMITTEE ON PROCUREMENT

AND

MILITARY NUCLEAR SYSTEMS

COMMITTEE ON ARMED SERVICES

U. S. HOUSE OF REPRESENTATIVES

BY

ALPHONSO A. TOPP, JR.

CHIEF, RADIATION PROTECTION BUREAU

ENVIRONMENTAL IMPROVEMENT DIVISION

HEALTH AND ENVIRONMENT DEPARTMENT

STATE OF NEW MEXICO

Mr. Chairman and Members of the Subcommittee:

My name is Al Topp. I am Chief of the Radiation Protection Bureau in the Environmental Improvement Division of the New Mexico Health and Environment Department. I appreciate the opportunity to testify regarding the stabilization and management of commingled uranium mill tailings piles. With me is Mr. Gerald Stewart who is Chief of my Uranium Licensing Section. He will respond to any technical questions concerning our regulatory program for uranium extraction facilities and uranium tailings piles.

At the outset of my statement, I wish to thank you, Mr. Chairman, for tne Stratton Amendment to the Energy and Water Development Appropriations Bill which enabled New Mexico to retain regulatory authority over uranium mill tailings through this fiscal year.

We have read the Department of Energy's Commingled Tailings Study dated June 30,1982. We have verified to the best of our ability the portion of the study pertaining to New Mexico. In general, we are in agreement with the study and its recommendatons. We believe an equitable cost sharing arrangement can be achieved. It should be noted that in June, the Environmental Protection Agency submitted revised inactive tailings pile standards more nearly approaching New Mexico regulations to the Office of Management and Budget. We understand that OMB returned the revised standards indicating that they do not meet Presidential guidance regarding cost.

My testimony shall cover the situation in New Mexico to include: production, licensed capacity, accumulated tailings, regulatory program, regulation development, and radiation protection philosophy. I shall give the rationale behind our regulations regarding stabilization and some thoughts concerning cost.

Through last year, New Mexico's uranium industry produced about half of the uranium "yellowcake" in the United States. Our licensed production capacity for five operational uranium mills is 22,160 tons of ore per day. Two recently licensed mills, when completed and operating will add an additional 6,400 tons per day capacity. Under the present market conditions, New Mexico uranium ore processing is about 5,300 tons per day. Since some of our uranium mills have operated for over 20 years, we have accumulated a total of 88 million tons of uranium mill tailings. These tailings have a surface area of about 1,300 acres. No other state, agreement or non-agreement, exceeds these values. New Mexico has 55 percent of all tailings and 56 percent of the commingled tailings. If the 1,300 acres of tailings were to be covered with three or more meters of earth as required by NRC regulations, this would require over 36 square miles (23,000 acres) to be denuded of soil. We believe this is utter nonsense and should not occur.

New Mexico began its regulatory program as an Agreement State in 1974 and has evolved from one person in 1974 and 116 pages of radiation protection regulations to a professional staff of seventeen in 1982 and 200 pages of regulations. My Uranium Licensing Section has over 100 man-years of radiation related experience and includes one Ph.D., five with master's degrees, and one B.S. degree. In addition, a complete staff of air and water specialists is available within the Division. The New Mexico State Engineer provides review, approval, and inspection of dams. Our regulatory program has regulations that have been in place for control of uranium mill tailings since 1974 and stabilization since 1979. Thus, regulations are in existence and are being enforced. A chronological chart demonstrating New Mexico's compliance with the Uranium Mill Tailings Radiation Control Act of 1978 is attached. Unfortunately, New Mexico's request for an amended agreement with the NRC has not yet been approved. NRC is currently evaluating our proposal.

Later you will hear from Mr. George Hensley, the Chairman of the New Mexico Environmental Improvement Board about the Board's 1981 deliberations on the mill tailings portion of the radiation protection regulations. New Mexico's regulatory development process is time consuming. It involves public comments on proposed drafts. We have a Radiation Technical Advisory Council which reviews draft regulations in public meetings. Our Board conducts public hearings on proposed regulations with the Council in attendance. The hearings before the Board are adversary with proponents and opponents. The process includes sworn testimony, cross examination, transcripts, and judicial review. In adopting any regulations, the Board is charged by law to consider the real protection to the public and environment, the economic impact, and the technical feasibility of the proposed regulation. Finally, the Council must consent with the Board's action. This process results in a strong regulatory program with regulations that are practicable; protective of the public health, safety and the environment; enforceable and respected.

Our policy for radiation protection is founded upon recognized radiation health protection standards established over many years by international and national conferences on radiation protection and proven to be effective. We also consider as fundamental to our program the concept that any unnecessary radiation must be minimized; that is, as low as reasonably achievable, taking into account the economics of improvement in relation to benefits to public health and safety. In addition, we believe that the radiation emitted by uranium fuel cycle activities should be considered no different than radiation from the same radioisotopes from any other radiation activities. It is our opinion that the penalty against the uranium fuel cycle requiring a factor of 20 reduction in the dose to the nearest resident is unwarranted. If an applicant for a license to use natural uranium, but not involved with the uranium fuel cycle, were to approach the NRC and he could show that the total dose to any member of the public would not exceed 500 millirem per year, the NRC would be obligated to approve his application. Under 40 CFR 190 the uranium fuel cycle including mills is restricted to a dose to the nearest resident of 25 mrem per year exclusive of radon and radon daughters. The 25 mrem per year standard cannot be measured directly and therefore must be inferred with computer modeling techniques. I should point out that 25 mrem per year is approximately the cosmic radiation equivalent to an increase in altitude of 2500 feet; like moving from Albuquerque to Santa Fe which people do without any hesitation. To add another perspective to this issue, those who move from sea level to Santa Fe increase their radiation exposure by almost three times from about 80 mrem per year to about 200 mrem per year. Some of our fastest growing areas in the southwest result from such population movement and the increased background radiation is seldom, if ever, considered by those making such moves. I am aware of no demonstration by epidemiological methods that shows that those of us in higher radiation background areas suffer from the higher radiation background. I believe the 25 mrem per year standard provides no necessary health protection and should be abolished.

The emissions from uranium mill tailings piles involve gamma radiation, airborne particulates, radon and seepage into ground water of radioactive and non-radioactive contaminants. Measurements around tailings piles have indicated that beyond about one-half mile from tailings piles, radon from piles cannot be distinguished from background levels. Since a thin cover of earth material will stop all airborne particulates, the only airborne radioisotope of concern is that of the noble gas radon. The earth emits radon naturally at a rate between 2.5 and 3 gigacuries of radon per year. The atmosphere contains 40 megacuries of radon at all times. We are immersed in air which contains radon, both outside and inside structures. Since radon concentrations cannot be distinguished from background beyond a one-half mile from a tailings pile, New Mexico first attempted to keep people beyond this distance from a tailings pile. This very simple, easily understood concept was lost in our 1979 hearings because NRC considered this to be an institutional control and it was opposed by industry. I should also point out that New Mexico has no problem with considering stabilized tailings piles as dedicated land where access can be restricted and periodic surveillance and maintenance can be accomplished. We believe the concept of restricted access, surveillance and maintenance will enable a stabilized tailings pile to last indefinitely. This we consider to be a major objective of our stabilization regulations.

Table 2 on page 13 of the DOE Commingled Tailings Study compares mill tailings standards and regulations. For the purpose of discussion I have reproduced the table. It should be noted that the EPA column was changed in the recent submittal to OMB. I shall give you the rationale behind our regulations as shown in the right column.

The 200 year longevity was selected because expert witness testimony established the fact that the engineering profession is prepared to accept only 200 years as a rational and definitive design goal. With public access denied and programmed inspection and maintenance, which is assured by our Continued Care Fund, we believe such stabilized piles as are turned over to the State will last far in excess of 200 years. Our Continued Care Fund is in existence now. It contains over five million dollars and is earning over fifty thousand dollars per month in interest. The fund is dedicated to inspection and maintenance of uranium mill tailing piles accepted by the State from contributors to the fund. Additionally, surety arrangements for stabilization of all of our existing tailings piles is guaranteed by financial arrangements now in existence in accordance with our regulations.

Radon emanation rate is not a health standard. Therefore, we have not utilized a radon emanation rate because we consider the rate to be of little importance if the radon concentration in air standard at the area boundary is met. It is radon concentration, indeed radon daughter concentration, not radon emanation rate, that presents a hazard to people. We have no objection to the use of an emanation rate to describe a source term to model boundary concentrations. We will insist that permissible concentrations must be demonstrated by the licensee or agency stabilizing a pile before the State will accept custody of the pile.

We believe New Mexico Water Quality Control Commission Regulations provide adequately for seepage control of non-radiological contaminants. New Mexico led the way in establishment of such regulations and we have found our water quality regulations to be both adequate and enforceable. We question seriously the recent EPA proposal of 10 picocuries per liter uranium drinking water standard as not being necessary for public health purposes and failing to recognize the natural background of ground water in New Mexico. We consider the proposed standard to be totally out of context with the physical environment and health protection standards.

I am pleased to be able to agree with the NRC on radon in air concentrations. I would note that these values were established years ago and have stood the test of time. If there is a radon problem, we think these values regulate it appropriately. It should be noted that the concentrations are values above background.

We see no need in specifying a cover thickness if the above parameters are met.

In the opinion of the New Mexico Environmental Improvement Division, our regulations are practicable, technically feasible, and provide adequate radiological protection to our citizens. We believe the cost to implement our regulations is commensurate with achievable health benefits.

While I have no ability to critique the DOE's cost estimates for commingled piles, I assume the estimates are generally correct. It is obvious that commingled piles should not be stabilized to standards any different than say, inactive piles. To consider the total uranium mill tailings problem correctly, all stabilization and reclamation costs for all piles should be considered. Since the cost of all tailings stabilization will be large, no matter who pays for it, stabilization standards must be justified based upon proven radiological standards with appropriate considerations for natural background. Society can not afford either extravagent or inadequate solutions.

So far my statement has addressed only stabilization of uranium mill tailings piles. I believe that I would do a disservice not to address another subject not yet discussed. This is the matter of widespread, technologically enhanced background resulting from low-level radiological contamination from all uranium activities including uranium mining, ore storeage, and ore transportation. We asked the NRC to consider this in their Generic Environmental Impact Statement on Uranium Milling but the NRC declined citing lack of authority. The environmental impact does not go away from New Mexico so simply.

Our Ambrosia Lake area, which has the most intensive underground uranium mining in the free world, appears to have somewhere between thirty and sixty square miles affected by low-level contamination to some degree over the many years by wind--blown material--some natural, some mined but not yet milled, and some mill tailings. It is not possible at this time to identify or isolate the source of one radioactive contaminant from another. As a further complication, the Kerr-McGee tailings piles, the largest commingled pile, and the old Phillips pile, a Title I UMTRCA pile, are in the same area. In my opinion, even if both of these piles were covered to NRC standards, the average radon concentration in the Ambrosia Lake area would not be reduced by a detectable amount. This reduction may not be detectable even after all mining stops. This area is very sparsely populated and used as grazing where sufficient growth is available. It seems rather futile to spend a lot of money covering tailings piles in a mining area To do so would create a nice clean spot in the middle of a big dirty spot at great expense--hardly a cost--effective effort.

Who pays for it? The Director of the New Mexico Environmental Improvement Division went on record May 23, 1979 advocating in a letter to the Comptroller General of the United States, "that Congress provide assistance to the active mill owners to share in the cost of cleaning up that portion of the commingled mill tailings that were generated under federal contracts." We commend Congress for the wisdom and fairness shown by Public Law 96-540. We hope sincerely that appropriate stabilization standards similar to New Mexico's will be selected and that adequate funds provided to solve this important problem.

This concludes my statement. I shall answer questions to the best of my ability.

NEW MEXICO'S COMPLIANCE WITH UMTRCA

May 1977	NRC issued Branch Position on "Performance Objectives" for uranium mill tailings impoundments.
Sept. 1977	New Mexico included "Performance Objectives" in New Mexico Uranium Mill License Application Guide.
March 1978	New Mexico prepared draft revision to New Mexico Radiation Protection Regulations (NMRPR).
June 1978	New Mexico testified at Congressional Hearings on Uranium Mill Tailings Radiation Control Act.
Nov. 1978	UMTRCA passed by Congress.
Dec. 1978	Agreement States meeting in Colorado Springs on early GEIS draft. First discussion of amended agreement being required and concurrent tailings licensing.
Feb. 1979	Draft of revision to NMRPR submitted for public comments. Revision included issues for UMTRCA compliance.
March 1979	Radiation Technical Advisary Council (RTAC) meeting on NMRPR.
May 1979	Environmental Improvement Board (EIB) public hearing for six days on revised NMRPR to meet UMTRCA.
August 1979	NRC issues proposed rules based on draft GEIS.
Sept. 1979	Revised NMRPR submitted to EIB for approval and filing.
Oct. 1979	NRC public hearings on draft GEIS, industry and New Mexico testified against NRC standards.
Nov. 1979	EIB approved revised NMRPR but deferred filing at industry request to hear more arguments.
March 1980	EIB public meeting on industry request to defer three sections from the regulations for future hearings.
April 1980	EIB acted on industry request and deferred sections on performance objectives, bonding and buffer zone. EIB instructed that alternative requirements would not apply to existing sites. Revised NMRPR filed on April 21, 1980 and were effective 30 days later.

Oct. 1980	NRC published final rules based on final GEIS. These rules followed those published on draft GEIS August 1979.
Nov. 1980	RTAC meeting on proposed draft of remaining NMRPR revisions necessary to comply with UMTRCA.
April 1981	RTAC meeting on final draft. Members requested copies of GEIS and EPA EIS on "25 Millirem Rule."
May 1981	RTAC meeting on technical aspects of NRC rules. NRC and industry presented technical statements.
June 1981	EIB pubic hearing on proposed NMRPR revisions.
August 1981	Hearing record closed. Transcript available for review.
Sept. 1981	Final revised NMRPR approved by EIB.
Oct. 1981	Revised NMRPR filed.
Nov. 1981	Revised NMRPR effective. First draft amended agreement package submitted to NRC - November 2, 1981.
Jan. 1982	Sutin decision upheld. Deleted 3-300J land ownership from NMRPR.
Feb. 1982	NRC letter and meeting concerning clarification of items in regulations for amended agreement.
Feb. 1982	RTAC meeting on proposed 3-300J land and tailings ownership.
March 1982	EIB meeting to set hearing date of April 22, 1982 for 3-300J. Public notice out March 15.
April 1982	EIB hearing for 3-300J.
May 1982	Transcript for April 22, 1982 EIB hearing received. Final draft amended agreement completed and sent to NRC.
June 1982	Final comments on hearing record submitted 7 June 1982.
July 1982	EIB/RTAC meeting on 3-300J language 9 July 1982.

Extracted from: DOE/DP-0011, Commingled Uranium Tailings Study, Volume 1, Plan for Stabilization and Management of Commingled Uranium Mill Tailings, June 30, 1982, U. S. Department of Energy, Assistant Secretary for Defense Programs, Office of Defense Waste and Byproducts Management, page 13.

Table 2. Proposed Uranium Mill Tailings Stabilization Standards and Regulations

Standard/Regulation	NRC[a]	EPA[b]	New Mexico[c]
Longevity (years)	1000+	1000	200
Radon Emanation Rate (pCi/m^2-sec)	2	2	Not Specified
Ground Water Requirements	No Degradation	EPA Drinking Water Standards	New Mexico Water Quality Criteria
Radon Concentration (pCi/l)			
On Tailings Area	30[d]	Not Specified	30
At Area Boundary	3	Not Specified	3
Cover Thickness (meters)	3	Not Specified	Not Specified

[a]For new tailings piles.

[b]For inactive tailings piles.

[c]State of New Mexico Environmental Improvement Board, "Amended Radiation Protection Regulations and Statement of Reasons for Their Adoption," October 9, 1981.

[d]Same as 10 CFR Part 20, App. B-II.

New Mexico's Philosophy

for

Reclamation and Stabilization

of

Uranium Mill Tailings

Design stabilization for 200 years against erosion

Comply with New Mexico Water Quality Control Commission regulations

Allow institutional controls

Provide for inspection and maintenance to assure long term stabilization

Continued care fund in existence for inspection and maintenance

Perform remedial maintenance promptly to eliminate future problems and reduce costs and extend stabilization life

Require surety arrangements to assure final stabilization

Reclamation compliance by measurements to demonstrate meeting health standards

Use existing radiation protection standards

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202/861•2800
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...ENT

Testimony of George B. Rice, Vice President,
Kerr-McGee Corporation, on behalf of the
American Mining Congress before the
Subcommittee on Procurement and
Military Nuclear Systems of the
Committee on Armed Services

August 18, 1982

Testimony of Mr. George Rice
Vice President of Kerr-McGee Corporation
on behalf of the American Mining Congress
August, 1982

Mr. Chairman and members of the Subcommittee, my name is George Rice. I am a vice president of Kerr-McGee Corporation, a company long-involved in this Nation's domestic uranium industry. I am also Chairman of the Uranium Environmental Subcommittee of the American Mining Congress, a trade association whose membership includes companies that mine and process a large portion of the Nation's uranium. I am here today with Jack Vogt of Union Carbide Corporation to discuss, on behalf of the AMC, implementation of the Uranium Mill Tailings Radiation Control Act by NRC and EPA.

In implementing the Act, NRC in its Uranium Mill Licensing Requirements and EPA in its proposed inactive site standards have called for private industry and DOE to take a number of unreasonable measures essentially to eliminate the emanation of radon, a naturally occurring inert radioactive gas, from tailings piles. These unreasonable measures are inconsistent with the negligible health risks posed by the very small amount of radon emitted by the tailings. We believe that the NRC and EPA approach is contrary to the intent of Congress and incompatible with generally-accepted approaches to setting radiation standards and requirements. In addition, it threatens to cost the domestic industry and taxpayers a billion dollars or more for minimal benefits. Further, these unreasonable actions compound the already serious economic problems of the domestic uranium industry, an industry vital to our national defense and energy security. It is accordingly imperative that the agencies modify their approach.

Dispersion and Misuse

Mr. Chairman, we believe there is a consensus that tailings piles should be stabilized to prevent dispersion or misuse of tailings material. The problem of misuse has been resolved by the provisions in the Mill Tailings Act which require government ownership and control of the tailings after stabilization has been completed.[1] Government control will assure that people do not occupy the disposal sites or use stabilized tailings for construction purposes.[2] This leaves only the problem of dispersion.

Dispersion is controlled by stabilizing the piles to protect them against erosion. The key issue is how long the tailings must be so protected without the need for any long-term maintenance. We believe a period of 100 to 200 years is reasonable for this purpose. And, there are engineering controls which can give a reasonable assurance of successful, cost-effective stabilization for this period of time. This would be accomplished by contouring the piles and covering them with one to two feet of earth and rock. Consonant with these views, the State of New Mexico, which is this Nation's largest producer of uranium, adopted extensive regulations providing for control against dispersion for 200 years.[3] The State's regulations additionally protect nearby residents by requiring that stabilized tailings meet radionuclide concentration limits equivalent to those contained in the basic health physics standards specified in NRC's 10 C.F.R. Part 20, App. B.[5] The New Mexico uranium industry believes the State's approach is fair, reasonable, well-supported, and fully protective of the public health and safety. In addition, the State approach has won the endorsement of DOE.

NRC's Approach Is Fundamentally Flawed

Unfortunately, NRC and EPA have diverged from the approach developed by New Mexico and endorsed by DOE. NRC has instead developed a set of regulations, known as the "Uranium Mill Licensing Requirements," which are devoted to reducing the emanation of radon to 2 pCi/m^2-sec -- a level close to the average natural background radon flux rate.[6] The proposed EPA standards for inactive sites contain a similar provision. The NRC regulations also require that tailings be moved for burial below-grade or else spread out to have slopes approaching 10h to 1v and covered with no less than three meters of earth.[7]

Costs

The NRC approach will be extremely costly to impleme.[illegible] The Commission has calculated that its radon regulations could cost the domestic industry a billion or more dollars.[8] Industry and DOE estimates indicate the costs could be higher.[9] The exact cost, however, is impossible to project. This is largely because many of the NRC regulations are open-ended in nature. Although they impose certain minimum requirements, they embody no limits on what the agency may in the future require at any given uranium processing site. My company, Kerr-McGee, has estimated that if a number of NRC's minimum requirements were waived, the cost to stabilize our Ambrosia Lake mill tailings would be about $20,000,000, not counting inflation, and under the most favorable of engineering assumptions. However, if we are required to cease use of our tailings pile and move future tailings to a new site, the cost would exceed $80,000,000. The stabilization costs would be much greater if we were required to move the tailings already in existence.

Mr. Chairman, we understand that some NRC staff state that expensive movement of tailings piles will not be required. However, certain actions being taken by NRC at the two active processing sites currently ready for stabilization raise questions as to whether movement will in fact be demanded. In particular, an NRC draft environmental impact statement requires TVA to move all the tailings at its Edgemont facility. And NRC has failed to endorse permanent stabilization in place at Kerr-McGee's thorium facility in West Chicago.

The uncertain nature of the NRC regulation leaves industry at a loss to calculate final costs. In spite of what well-intentioned regulators may state today, there is no way to know what future regulators will ultimately require once tailings are ready for final stabilization. The NRC regulations make business planning virtually impossible and pose the threat of very substantial increased liability down the road.

In addition to these economic factors, the NRC regulations will result in substantial environmental disruption from moving the vast quantities of earth and sand necessary to comply with NRC's below-grade and three meters cover requirements.

Risks

It might make sense to incur the heavy burdens associated with the NRC/EPA approach if radon from tailings posed a significant risk. However, it does not. Epidemiological studies have uniformly failed to detect any adverse effects from exposure to the low levels of radon associated with mill tailings.[10] The risk posed by that exposure is thus purely hypothetical. It is based solely on worst-case estimates under the linear nonthreshold model.[11] Even the worst-case risk which NRC calculates under that model is de minimis. The hypothetical annual risk to the average individual works out to only about 1 in 200,000,000 from all active uranium processing sites combined.[12] This hypothetical risk, which we believe is substantially overestimated,[13] is incredibly small. To give some perspective, the actual risk from being killed by a tornado is about 1 in 2,000,000 -- one hundred times greater than that hypothesized to be associated with radon from mill tailings; the hazard from drinking one pint of milk per day or merely from being in a room with a smoker is about 1 in 100,000 -- about 2,000 times higher; and the average risk from government employment is about 1 in

10,000 -- approximately 20,000 times more excessive. The maximum hypothetical risk to nearby residents is also minute. Sandia National Laboratories has compared that hazard to the risk of being struck by lightning.[14] I am attaching to my testimony a chart, entitled "Insignificance of Radon from Tailings," which summarizes some of these data.[15]

Senior NRC staff, in a memorandum only recently made public, have confirmed that radon poses an insignificant hazard to the general population. The staff explained that:

> "[t]he effects of radon from tailings on the distant or continental population, while calculable, are judged by the staff and others to be of little or no real significance and by themselves would not justify the uranium mill tailing regulations . . . . The staff has always recognized that such radon releases constitute a very small, essentially immeasurable and insignificant, contribution to the radon exposure of the general population."[16]

The staff also noted that the worst-case risk to nearby residents was "very small."[17] Similarly, NRC's lawyers admit that the evidence concerning risk to nearby residents does not support the NRC's costly approach.[18] The staff's conclusion that radon releases pose an insignificant hazard is consistent with that reached by NRC's Atomic Safety and Licensing Board. In its Perkins decision, the Board explained that "the release of radon-222 [from tailings] and health effects that can reasonably be associated therewith" are "insignificant."[19]

NRC and EPA have failed to address the question of whether radon from tailings poses a significant risk, and, if so, to whom. To the extent that they pay it heed, the agencies claim that the Mill Tailings Act requires them to regulate radon flux regardless of the insignificance of the risk it poses. For example, in a recent letter to several uranium mill managers who expressed concern on this very point, EPA's Deputy Administrator, Dr. Hernandez, suggested that regulation of radon flux is required by the preamble to the Mill Tailings Act.[20] The Deputy Administrator is wrong. Congress never intended for NRC and EPA to impose billion dollar requirements upon taxpayers and the domestic uranium industry without regard to level of hazard and the costs involved.

Mr. Chairman, it is essential that regulatory agencies recognize, in the words of the Supreme Court, that "'safe' is not the equivalent of 'risk-free.'"[21] The agencies must take into account the insignificance of purported hazards such as that involved here. A risk-free environment is simply not possible in a modern, technological society.[22] We would all be out of work, and our health and safety would certainly suffer, if such an environment were demanded.[23] Moreover, it would be equally irrational and counterproductive to demand zero-risk of activities associated with nuclear power. For one thing, that arbitrary and unrealistic standard will translate into higher costs. This will predispose the marketplace against nuclear power, which is one of the safest energy alternatives. The ironic result will be an increase in overall societal risk as well as a waste of money -- in the economist's vernacular, a "misallocation of resources."[24] The Department of Energy has recently reiterated the importance of these considerations. In comments on a recent GAO report, DOE has recommended that radiation standards for clean-up and stabilization activities should be "realistic and balanced with consideration of risks and costs accepted by society for non-nuclear activities."[25] The GAO concurred in DOE's position.

Economic and Environmental Costs

There is another major flaw in NRC's approach. NRC did not balance the economic and environmental costs imposed by its regulations. This is a marked and unwarranted departure from past practice. Until now, it has always been recognized that costs must be balanced with the benefits achieved in setting radiation standards. This approach is embodied in the Radiation Protection Guidance for Federal Agencies issued by the Federal Radiation Council in 1960. It is endorsed by national and international standard-setting organizations. The National Council on Radiation Protection, for example, has explained that

> "the setting of radiation protection standards requires consideration of compensatory trade-offs between currently assumed hazards and benefits."[26]

Similarly, the International Atomic Energy Agency has declared, in specific reference to standards for stabilization of uranium mill tailings, that "social and economic considerations" should be taken into account.[27] Consideration of costs is also embodied in the "as low as reasonably achievable" (ALARA) principle found in 10 C.F.R. § 20.1(c) of NRC's regulations.[28] Indeed, EPA's Policy Statement on the Relationship Between Radiation Dose of Effect explains that costs must be weighed when risks are assessed under the linear, nonthreshold model.[29]

The NRC environmental impact statement asserts that the NRC staff cannot weigh costs because the risks are so speculative and arbitrary.[30] Mr. Chairman, we agree that the risks are speculative and arbitrary but this is precisely why costs should be weighed. NRC's argument simply subverts the long-established approach in radiation standard-setting and leads to imposition of unsubstantiated regulatory requirements. NRC's failure to weigh costs would not make sense even if the uranium industry could afford them. It certainly does not make sense when the uranium industry is collapsing; when 60% of its employees are out of work in the key uranium producing states; and when the remaining mines and mills are being curtailed or closed.

The NRC/EPA approach is leading to illogical results. For example, naturally-occurring indoor radon is the principal cause of radon exposure. Although the gove[illegible]t recognizes the much higher risk from indoor radon it is heavily encouraging even greater exposures through tax subsidies for insulation and conservation. It is obviously inconsistent, arbitrary and unreasonable for NRC and EPA at the same time to seek to impose billion dollar burdens on taxpayers and the domestic industry to eliminate the de minimis radon exposures associated with mill tailings.

Churning

Finally, we also note that the NRC requirements were issued in advance of EPA standards. This action is contrary to section 275 of the Atomic Energy Act which in our view clearly provides for EPA to issue final standards before NRC issues more detailed regulations. In addition, NRC's action in advance of EPA subjects industry and Agreement States to administrative confusion and wasted effort because the NRC regulations will eventually have to be conformed to the EPA standards.

Clean-up Standards

Mr. Chairman, important concerns are also raised by recent actions by EPA and NRC with respect to "clean-up" or "decommissioning" standards for uranium mills and related nuclear facilities. I will focus on EPA's proposed 5 pCi/gram radium standard for inactive sites and a recent Branch Technical Position issued by NRC.

EPA advanced a 5 pCi/gm radium-226 clean-up standard for inactive uranium processing sites as part of its proposed inactive site regulations.[11] The agency is now threatening to apply this stringent standard across the board under the Superfund law. The 5 pCi radium standard is not supportable. It is far less than many naturally occurring concentrations of radium. Under the assumption of a 10% occupancy factor, which we believe is realistic, a 5 pCi radium standard translates into a de facto exposure limit of about 5 mrem per year --at least 20 times less than the average natural background exposure of 100 to 200 mrem. This stringent limit is not required on the basis of health considerations. In addition, it will be extremely expensive and environmentally disruptive because it will require excavating vast quantities of earth for movement and disposal. It is also so low that it will be virtually impossible to measure in order to verify compliance. In sum, the proposed standard is not justified in terms of health, economics, or enforceability.

NRC has not issued formal regulations applicable to mill site decommissioning. The Commission, however, has taken another approach to this issue. It has published, without complying with rulemaking procedures, a "Branch Technical Position" which in effect imposes stringent clean-up standards applicable to at least some sites formerly employed for processing uranium and thorium.[32] The standards in the Branch Technical Position linked to EPA's controversial proposed 5pCi/gm radium standard. The standards which the Branch Technical Position embodies are therefore themselves unduly stringent. Indeed, the NRC limits transform into exposure limits which are about 40 to 50 times lower than the 500 mrem exposure standard for unrestricted areas contained in 10 C.F.R. Part 20.[33] Similarly, they amount to concentration limits 40 to 50 times less than those contained in the AEC/NRC decontamination guidelines. The Branch Technical Position is thus considerably harsher than either of the two decontamination standards previously employed. We believe that the NRC limits, if applied across the board, would be extremely costly to private industry and to the federal government.

Conclusion

Mr. Chairman, a viable domestic uranium industry is essential to assuring our Nation's defense and energy security. This country has devoted a substantial amount of money and effort to building a domestic uranium industry capable of supplying its needs for precisely these reasons. It would be tragic and shortsighted to jeopardize that investment and the important national interests at stake through the imposition of costly regulatory requirements addressed to hypothetical and remote risks.

We do not dispute the need for reasonable regulation. EPA and NRC, however, have failed to balance factors such as risk significance, economic and environmental costs, and comparative risk analysis in devising their requirements. It is imperative that these errors be corrected.

Mr. Chairman, there are a number of reports which we believe are highly relevant to the issues addressed in my testimony. With the Subcommittee's permission, I would like to submit four of these for inclusion in the record. These reports include the following:

(1) University of Pittsburgh report entitled "The Health Effects of Low-Level Radon Exposure in Canonsburg, Pennsylvania." This recent study, which is continuing, found no increased incidence of lung cancer associated with the Canonsburg inactive uranium processing site.

(2) The summary to NCRP's Report No. 43, cautioning against overreliance on the linear non-threshold model and indicating that costs should be balanced in setting radiation standards.

(3) Testimony by Dr. Bernard Cohen, given October 19, 1979, entitled "Radiological Risk in Perspective and the Mechanisms for Making Rational Decisions on Risk Reduction." This testimony discusses some of the flaws in the rationale employed by NRC staff in addressing the radon issue in NRC's Generic Environmental Impact Statement on Uranium Milling.

(4) A report Dr. Edwin Still, D.V.M., calculating the total amount of radon released from all mill tailings piles, assuming no radon controls. The report indicates that the amount is less than 1/20 ounce per year. This supports independent calculations by Dr. Evans and is consistent with measurements finding that radon from tailings is readily dispersed and is not detectible 1/4 to 1/2 mile from tailings sites.

We express our appreciation for this opportunity to state our views on these issues of vital importance to our industry.

ENDNOTES

[1] 42 U.S.C. § 2113. The statute also provides for private operators to post a sum sufficient to cover the costs of necessary long-term maintenance. 42 U.S.C. § 2201(x).

[2] We note that NRC in its Generic Environmental Impact Statement on Uranium Milling (GEIS) has erroneously assumed that the government will fail and that people will permanently occupy mill tailings sites.

[3] N.M. Radiation Protection Regulations § 12-300(B).

[4] See id. 10 C.F.R. Part 20, App. B specifies a radon/radon daughter concentration limit of 3 pCi/liter radon or .03 WL radon daughters for unrestricted areas.

[5] Significantly, senior NRC staff appear also to agree with the New Mexico approach. In a December 10, 1981 memorandum, NRC staff expressly indicated that the focus of regulations should be on controls to prevent dispersion of tailings or their misuse. Memorandum, Messrs. Kreger, Lowenberg & Mills (NRC) to Mr. Bickwit (NRC), Dec. 10, 1981.

[6] See 10 C.F.R. Part 40, App. A, Criterion Six.

[7] See 10 C.F.R. Part 40, App. A, Criteria Three and Four.

[8] NRC's cost estimates are obscure. The Commission gives cost estimates only for compliance at hypothetical new mills, few if any of which are likely to be constructed or operated under current market conditions. NRC estimates that the cost to meet the 2 pCi/m^2-sec radon flux limit at hypothetical new mills will be at least $340,000,000 (GEIS at 12-22); that the cost for below-grade disposal will be approximately twice as much (GEIS at 12-8); and the cost for water protection will be equivalent to that for radon. Compare GEIS at 22 with GEIS at 18. In sum, the cost to comply with the NRC regulations will likely exceed one billion dollars by NRC's calculations.

[9] The costs will be greater than calculated by NRC at the active uranium processing sites to which the NRC regulations will in fact apply. This is because existing mills were not sited for the kind of tailings disposal NRC now seeks to require. The cost of moving a single existing pile for below-grade disposal (as NRC's criterion three seems to require) will be in the $100,000,000 range.

[10] NRC, GEIS at A-35; Addison, Excess Cancer Risk Estimates from Exposure to Gamma and Radon Daughter Levels in Mesa County, Colorado, in Uranium Mill Tailings Management 169 (C.S.U. 1981).

[11] The linear non-threshold hypothesis assumes that because very high doses of radiation cause health effects, there will be proportional effects at low levels. The linear non-threshold model is frequently used for calculating a "conservative" worst-case risk estimate for regulatory purposes. The federally chartered National Council on Radiation Protection has expressly cautioned that hypothetical fatalities calculated under the linear non-threshold model should not be confused with actual hazards. NCRP, Review of the Current State of Radiation Protection Philosophy (Report No. 43) at 4 (1975).

[12] NRC calculates a hypothetical risk of about 1 in 70,000,000 for three times the number of mills currently operating or expected. See GEIS at 19.

[13] For one thing, NRC uses an excessive risk estimator. NRC projected a risk of about 3.6 in 10,000 for one "man-WLM" exposure. Six prominent authorities have indicated that the risk can be no greater than 1 in 10,000 per man-WLM and could be zero. See Evans, et al., Estimate of Risk from Environmental Exposure to Radon-222 and Its Decay Products, 390 Nature 98 (March 12, 1981). In addition, most of the hypothetical fatalities calculated by NRC are at distances many miles from tailings piles. However, increased radon from tailings cannot be detected more than about 1/2 mile from a tailings pile, even in the downwind direction. See, e.g., Shearer & Sill, Evaluation of Atmospheric Radon in the Vicinity of Uranium Mill Tailings, 17 Health Physics 77 (1969).

[14] L. Hanchey, Uranium Mill Tailings and Radon, reprinted in Uranium Ore Residues: Potential Hazards and Disposition, Hearings before the Procurement and Military Nuclear Systems Subcomm. of the House Armed Services Comm., 97th Cong., 1st Sess. 513-14 (June 24 & 25, 1981).

[15] The material for the chart is derived from the following sources: Testimony of Prof. Richard Wilson (Harvard), OSHA Docket No. H-090; EPA, Draft EIS for Remedial Action Standards for Inactive Uranium Processing Sites (40 CFR 192) at p. 4-20 (1980)(1 in 21,000 per year risk estimate for naturally occurring indoor radon); Goldman, Radon: The Ubiquitous Pollutant (1980).

[16] Memorandum, Messrs. Lowenberg, Kreger & Mills (NRC) to Mr. Bickwit (NRC) (Dec. 10, 1981).

[17] Id.

[18] Memorandum, Messrs. Slaggie & Trubatch to Messrs. Kreger, Lowenberg & Mills (March 18, 1982).

[19] In the Matter of Duke Power Company (Perkins Nuclear Station, Units 1, 2 and 3), 8 NRC 87, [1975-78 Transfer Binder] Nuclear Reg. Rep. (CCH) ¶ 30,312 at p. 28,669 (July 14, 1978).

[20] Letter, Dr. Hernandez to Mr. Bailey, et al. (May 10, 1982).

[21] Industrial Union Dept. v. American Petroleum Institute, 448 U.S. 607, 642 (1980).

[22] Nader v. NRC, 513 F.2d 1045, 1050 (D.C. Cir. 1975).

[23] See Okrent, Comment on Societal Risk, 208 Science 372, 374 (1980)("Resources for the reduction of risks to the public are not infinite. At some point, a greater improvement in health and safety is to be expected from a stable and viable economy than from a reduction in pollution or the rate of accident").

[24] See, e.g., Nuclear Waste: What to Do with It? at 11 (1979) (Prof. Kenneth Arrow: "it would be pointless to demand a safety level for nuclear waste disposal that is so high as to prevent it from being achieved and then go to another cycle that has higher health hazards").

[25] GAO, Cleaning Up Nuclear Facilities -- An Aggressive and Unified Federal Program Is Needed 65-66 (1982).

[26] NCRP, Review of the Current State of Radiation Protection Philosophy (No. 43) at 2 (1975).

[27] IAEA, Current Practices and Options for Confinement of Uranium Mill Tailings (No. 209) at 72 (1981).

[28] 10 C.F.R. § 20.1(c) defines ALARA as follows:

> "The term as low 'as is reasonably achievable' means as low as is reasonably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socio-economic considerations, and in relation to the utilization of atomic energy in the public interest."

[29] EPA Office of Radiation Programs, Policy Statement on the Relationship Between Radiation Dose and Effect, March 3, 1975, reprinted at 41 Fed. Reg. 28409 (July 9, 1976):

> "The linear hypothesis by itself precludes development of acceptable levels of risk based solely on health considerations. Therefore, in establishing radiation protective positions, the Agency will weigh not only the health impact, but also social, economic and other considerations associated with the activities addressed."

[30] See NRC, GEIS on Uranium Milling at 12-19 (cost/benefit "can be quite arbitrary, given the highly subjective nature of some of the major factors and assumptions which must be decided upon to use it. . . .There is substantial uncertainty in the calculational models used to estimate the environmental transport of radon and its daughters, and resulting human exposure and potential health effects.") See also Letter, Dr. Palladino to Chairman Udall, April 26, 1982 at p. 4 (comment of Commissioners Gilinsky and Ahearne).

[31] See 47 Fed. Reg. 1822 (Jan. 13, 1981).

[32] 46 Fed. Reg. 52601 (Oct. 23, 1981).

[33] 10 C.F.R. § 20.105(a).

Insignificance of Radon from Tailings

Comparative Radon Releases

Source	Curies/yr. (U.S. only)
Natural sources	131,000,000
Agriculture	3,100,000
Uranium milling	150,000

Causes of Radon Exposure

Source	Percent of total exposure
Natural sources	43%
Building interiors (enhanced by insulation)	55%
Agriculture	1%
Natural gas use	0.9%
All other, including uranium milling	less than 0.1%

Perspective on Risks

Cause	Average individual risk/year
Smoker	1/300
Agricultural employment	1/1,700
Motor vehicle - total (1975)	1/4,500
Air pollution - sulphates	1/6,700
Government employment	1/9,100
Truck driving	1/10,000
Falls	1/13,000
Alcohol	1/20,000
Natural radon in buildings	1/20,000
Living downstream from a dam	1/20,000
Motor vehicle - pedestrian (1975)	1/25,000
Drowning (from recreational activities)	1/53,000
Inhalation and ingestion of objects	1/71,000
Home accidents	1/83,000
Bicycling	1/100,000
Person in room with smoker	1/100,000
One pint of milk per day (aflatoxin)	1/100,000
Accidental poisoning	1/170,000
Electrocution	1/200,000
Vaccination for small pox (per occasion)	1/330,000
Air travel - one transcontinental flight per year	1/330,000
Lightning	1/2,000,000
Tornados	1/2,000,000
Mill tailings at active sites, assuming <u>no</u> stabilization	1/200,000,000*

* The maximum hypothetical risk to the average individual from radon from three times the amount of tailings at active sites is about 1 in 70,000,000 according to NRC. This works out to a risk of less than 1 in 200,000,000 for current tailings.

6-17-82

University of Pittsburgh
GRADUATE SCHOOL OF PUBLIC HEALTH
Department of Epidemiology

THE HEALTH EFFECTS OF LOW-LEVEL RADON EXPOSURE IN CANONSBURG, PENNSYLVANIA

Residents of the Canonsburg/Strabane/Houston, Pennsylvania area have been concerned about health effects potentially resulting from radiation exposure due to the deposition of radioactive wastes from 1911-1954. It is now established that uranium miners exposed to radon concentrations thousands of times higher than those in Canonsburg may develop lung cancer in as much as fifty times the expected incidence in non-mining populations. They do not have increased incidence of other diseases, however. The University of Pittsburgh's Department of Epidemiology recently completed a study designed to determine if the health of Canonsburg residents has been affected by radon exposure from the uranium tailings.

Our case group consisted of lung cancer deaths occurring over a nineteen year period from 1961-1979. The comparison group was selected from among persons dying over the same time frame of arteriosclerotic heart disease (ASHD)- a disease not associated with radon exposure. Comparing radon exposures of lung cancer cases to radon exposures in the ASHD group enables us to determine if there was an association between lung cancer and exposure to radon. Our analyses revealed the following:

a. Lung cancer rates in the area were not higher than in other parts of Washington County.

b. Lung cancer cases did not cluster near the waste disposal site and were distributed geographically like the ASHD group.

c. Radon levels in the homes where persons developed lung cancer were similar to the levels in homes where lung cancer did not occur suggesting that the radon in the home did not contribute to the development of lung cancer.

d. Indoor radon levels in the area were consistent with background levels. That is, the radon levels in homes in Canonsburg are lower than levels found in other communities without radioactive waste disposal sites.

From the above results we may conclude the following:

a. The contribution to total radon dose received by Canonsburg residents from the dump site was less than the contribution from the regional geology.

b. Exposure to radon from the disposal of radioactive wastes did not have a significant impact on the health of the residents living in the area.

This study was supported by the Environmental Protection Agency and the American Lung Association of Southwestern Pennsylvania.

PITTSBURGH, PA 15261 (412) 624-3054

NCRP REPORT NO. 43

Review of the Current State of RADIATION PROTECTION PHILOSOPHY

Recommendations of the
NATIONAL COUNCIL ON RADIATION PROTECTION
AND MEASUREMENTS

Issued January 15, 1975

National Council on Radiation Protection and Measurements
7910 WOODMONT AVENUE / WASHINGTON, D.C. 20014

1. Introduction

During the past few years a number of reports dealing with assessment of the biological effects of radiation have been released. These include reports of the International Commission on Radiological Protection (ICRP) [1, 2, 3], the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) [4], the Advisory Committee on the Biological Effects of Ionizing Radiations of the National Academy of Sciences (NAS-BEIR) [5], and the National Council on Radiation Protection and Measurements (NCRP) [6]. Some of these have pointed out the basic philosophical problems in moving from our state of knowledge about the biological effects of radiation to recommendations as to acceptable levels of exposure for individuals, groups or the entire population. These philosophical problems present an area of continuing concern to the National Council on Radiation Protection and Measurements (NCRP), but one in which the Council has been moving slowly because of the uncertainties as to the basic relationships between dose and effect, especially at low doses and low dose rates. While all of the recently published reports are based on essentially the same data, different assessments and conclusions have been drawn and different applications have been proposed. Some of these differences are important, particularly the question of the use of the linear hypothesis in risk estimations at low radiation levels and the question of the use of such risk estimates in setting radiation protection standards. On these two issues the NCRP differs with the NAS-BEIR Committee Report [5] and, where applicable, is more in agreement with the UNSCEAR Report [4]. As a consequence, the NCRP decided that it should review the recently published reports [4, 5] for the purpose of identifying differences, their significance, and especially how they relate to the NCRP's recommendations relative to permissible exposures or dose limits for the public. The review resulted in the production of this report which includes the current position of the NCRP.

2. Current NCRP Position and Plans Regarding Radiation Protection Standards

A. Current NCRP Position

The National Council on Radiation Protection and Measurements, after reviewing recent developments relating to radiation standards for the public, particularly in regard to extrapolated estimates of cancer risk at low doses and low dose rates, takes the position that no change is required at this time in the conclusions set out in NCRP Report No. 39 issued in 1971. See Appendix A for the recommended dose limits established by NCRP Report No. 39 [6].

The NCRP position is centered on the principle that the "lowest practicable" radiation level is the fundamental basis for establishing radiation standards, and on the assumption that the most important radiation health hazards do not have a dose threshold. On this basis, the setting of radiation protection standards requires consideration of compensatory trade-offs between currently assumed hazards and benefits.

At such low radiation levels as are involved in the radiation protection standards, identification and quantification of both risks and benefits are so highly uncertain and imprecise at this time that the practice of balancing risks and benefits *numerically* is not useful to pursue without far more thorough and penetrating exploration.

Consistent with the normal practice of the NCRP, such exploration has been undertaken and the subject of radiation protection standards will be reconsidered when the studies described in Section B, below, have been concluded.

The NCRP continues to hold the view that risk estimates for radiogenic cancers at low doses and low dose rates derived on the basis of linear (proportional) extrapolation from the rising portions of the dose-incidence curves at high doses and high dose rates, as described and discussed in subsequent sections of this report, cannot be expected to provide realistic estimates of the actual risks from low level, low-LET radiations, and have such a high probability of overestimating the actual risk as to be of only marginal value, if any, for purposes of *realistic* risk-benefit evaluation.

Such risk estimates by themselves do not constitute justification for urgent action to make numerical radiation protection standards more restrictive than they now are, assuming that the application of such standards adheres to the basic principle of "lowest practicable levels" of dose.

In risk-benefit analysis for purposes of decision-making, numerical estimates of radiation-related risks, even when realistic, are of little use in a vacuum, i.e., without comparable numerical estimates of associated benefits, and of risks and benefits for alternative means to achieve the desired ends. When it becomes possible to analyze, quantify and weigh in the balance numerically the risks, benefits and costs of activities involving desirable or undesirable radiation exposure, on the one hand, and alternative means to desired ends on the other hand, the use of overestimates of risk for one alternative, e.g., one involving radiation exposure, unless counterbalanced by commensurate overestimates of risks from other alternatives, could deny benefits to society and could conceivably incur greater risks in some circumstances.

Before considering any further restriction of radiation protection standards, it is important to attain realistic values for risks and benefits, for weighing risks and benefits in decision-making, and for the most effective application of the principle of "lowest practicable level". This approach is important in order to avoid the expenditure of large amounts of the limited resources of society to reduce very small risks still further with possible concomitant increase in risks of other hazards or consequent lack of attention to existing greater risks.

Average exposure of the public to man-made nonmedical radiation, as estimated by the Environmental Protection Agency (EPA) [7], is now and is expected to be, even in the year 2000, only a very small fraction of either the natural background radiation dose or of the present upper limit of radiation protection dose limits for average dose to the population of interest. The EPA estimates that the per capita dose to the population in the year 2000 will be slightly less than at present.

The 1972 NAS-BEIR Committee Report states in its section on Summary and Recommendations, without developing the point in the body of the Report, that societal needs can be met with far lower average exposures and risks than permitted by the current Radiation Protection Guide of 170 millirems per year, and that to this extent the current Guide is unnecessarily high.

The risks and costs to society of further reductions of dose limits still need to be ascertained, however.

Numerical radiation protection guides or dose limits for the exposure of radiation workers or the general public are provided only as upper limits; all exposures should be kept to a practicable minimum. The NCRP has always assumed that its admonitions in this regard would be interpreted in a reasonable way. The application of this principle involves value judgments based upon perception of compensatory benefits commensurate with risks, preferably in the form of realistic numerical estimates of both benefits and risks from activities involving radiation and alternative means to the same benefits.

The linear dose-effect hypothesis has been coming into frequent use in analyses in which population exposures are expressed in the form of person-rem, including doses of one millirem per year or less to population groups and doses to individual organs, with linear extrapolation to damage estimates through the use of the NAS-BEIR Committee Report values. The indications of a significant dose rate influence on radiation effects would make completely inappropriate the current practice of summing of doses at all levels of dose and dose rate in the form of total person-rem for purposes of calculating risks to the population on the basis of extrapolation of risk estimates derived from data at high doses and dose rates.

The NCRP wishes to caution governmental policy-making agencies of the unreasonableness of interpreting or assuming "upper limit" estimates of carcinogenic risks at low radiation levels, derived by linear extrapolation from data obtained at high doses and dose rates, as actual risks, and of basing unduly restrictive policies on such an interpretation or assumption. The NCRP has always endeavored to insure public awareness of the hazards of ionizing radiation, but it has been equally determined to insure that such hazards are not greatly overestimated. Undue concern, as well as carelessness with regard to radiation hazards, is considered detrimental to the public interest.

The basis for the NCRP position, as well as indications of pertinent studies needed and being carried on by the NCRP, are given in subsequent sections of this report.

B. Current NCRP Plans Regarding Radiation Standards

In its continuing efforts to provide recommendations with respect to possible radiation hazards and radiation standards, the NCRP has taken the following actions:

TESTIMONY OF DR. BERNARD L. COHEN

RADIOLOGICAL RISK IN PERSPECTIVE AND THE MECHANISMS FOR MAKING RATIONAL DECISIONS ON RISK REDUCTION

My name is Bernard L. Cohen. I have worked as a nuclear scientist for over 30 years, and for the past 21 years I have been a professor of Physics at the University of Pittsburgh. From 1965-1978 I was Director of the Scaife Nuclear Laboratories. I was Chairman of the American Physical Society Division of Nuclear Physics in 1974-75, and am currently Chairman-elect of the American Nuclear Society, Division of Environmental Sciences.

The subject I will discuss today is how our society should approach decision making in the radiation health risk area. Risk is an inherent aspect of life itself. In whatever we do, wherever we go, we are constantly exposed to many risks. Indeed, we cannot eliminate these risks, we can only reduce them to some level that each of us individually, or our society collectively, considers acceptable.

The draft GEIS devotes much discussion to the potential risks from radiation from uranium mills. It assumes that there will be 82 model uranium mills each having a 2000-ton per day capacity operating in the United States by the year 2000. Each of these model mills will have a tailings disposal area from which radon gas will be emitted well into the future. Using a modelng analysis, the draft GEIS predicts anticipated adverse health effects on an annual basis from exposure of the general population to emissions of this radon gas from each tailings disposal area at a rate of 450 pCi/m^2-sec. The draft GEIS then calculates economic costs of reducing this exposure by limiting the radon flux rate to 2 pCi/m^2-sec above natural background levels.

To determine whether it is cost effective to impose this degree of radon flux control, a number of factors must be considered. The American Mining Congress will include in its written comments on the draft GEIS a detailed discussion of these factors. I will summarize the major points here.

Radiological Risks Relative To Other Daily Life Risks

The draft GEIS predicts that the long-term health effects to the North American population from radiation from the projected 82 model uranium mills will be less than 10 fatalities per year among the projected maximum 460 million population that will be reached in the next century. Translating this into today's terms for comparison purposes, this is equivalent to 4 fatalities per year in the present U.S. population. Currently, some other risks we all encounter cause the following number of annual fatalities in the U.S. population:

All accidents	100,000
Alcohol	50,000
Automobile accidents	50,000
Suicide	28,000
Homicide	21,000
Drowning	8,000
Illicit drugs	6,000
Poisons	4,000
Choking on food	3,000

Clearly the predicted adverse health effects from uranium milling milling are many orders of magnitude less than many other risks, including some that we do little to reduce any further.

A more striking perspective is gained by translating these uranium mill emissions risks into reduced life expectancy figures. The emissions from all the predicted mills would reduce future life expectancy by about fifteen (15) minutes. Other activities that cause this same life expectancy loss are (1) smoking 1½ cigarettes in a lifetime, (2) driving an extra ½ mile per year, (3) living in a house without a smoke detector for one month, (4) crossing a street one extra time every two years, (5) taking one short airplane flight in a lifetime, or (6) an overweight person eating 100 extra calories (such as one piece of bread and butter or one soft drink) in a lifetime.

Even within the narrow question of health effects of radon, there are much more serious things to worry about. Radon gas, of course, is part of the natural background radiation to which we are all exposed every moment of our lives. The government is urging us to insulate our buildings to save energy, but this traps radon gas inside for longer than normal times and hence increases our exposure to radon. If all U. S. homes were insulated to government specifications, the increased annual fatality toll from radon would be over a thousand times higher than that caused by mill tailings without covers.

Determination of an Appropriate Period of Integration for Health Effects Averted by Risk Reduction Techniques

At present the usual technique to reduce radon flux from mill tailings is to cover the tailings with some amount and type of material that will retard the radon emanation rate. While the health risk reduction benefits from covering tailings will extend into the future, the bulk of the economic, social, and environmental costs of the covering operations will occur much earlier--that is during the period of mill operation and decommissioning. Therefore, the benefits must be integrated over some reasonable period.

The draft GEIS seems to have essentially considered selection of an integration period as an intractable problem and part of the justification for not doing a cost effectiveness analysis. The problem may be difficult but it isn't impossible. It is not my purpose here to specify a single appropriate time period but rather to highlight the considerations that must go into selecting the integration period.

First, over extremely long time periods, erosion will bring essentially all the naturally-occurring uranium close enough to the earth's surface to permit radon emanation. If we integrate over very long periods, there is thus no net harm in mining uranium and creating mill tailings; the total number of health effects will be the same.

Second, an important consideration is the effect of discounting the money that would be available in the future to avert health effects but for its commitment now to complying with regulatory controls. For instance, assuming even a 1% annual real interest rate, for every million dollars spent now, we will forego the availability of $20 billion a thousand years from now to avert health effects.

Third, there are highly unpredictable factors in considering very long time periods. There may well be a cure for cancer, or an antidote for radiation, or it may be determined that low level radiation is harmless.

For all of these reasons, it is generally considered unreasonable to integrate effects beyond a few hundred years. Many prestigious scientific study groups, federal agencies, and international bodies routinely use integration periods in this range.

Selection of a Cost per Health Effect Averted Decision Criterion

Our society frequently makes judgments on how much saving a human life is worth in economic costs. The range of such costs per health effect averted provides the best background from which to make a judgment on such cost criterion. AMC's written comments will include a full presentation of these costs. I will only summarize the features here briefly.

In the area of medical screening and care, many fatalities could be averted at costs ranging from $10,000 to $200,000. Additional safety equipment is usually not included in automobiles when costs per life saved exceed about $200,000. Many lives could be saved in safety-oriented highway design improvements for costs ranging from $20,000 to $280,000 with several items in the $40,000 range.

These figures would suggest that if the cost per health effect averted by reducing radon flux from uranium mill tailings exceeds a figure in the range of the items just discussed, then it will be more cost effective to use our society's limited financial resources to save lives in these other areas rather than to commit these funds to radon flux control measures.

To demonstrate that a rigorous cost effectiveness analysis is indeed possible in this area, AMC has analyzed, on a preliminary basis and in draft GEIS terms using draft GEIS data, the cost per health effect averted of one of the proposed criteria -- criterion 6 dealing with reducing radon flux from uranium mill tailings. Dr. Harrison B. Rhodes of Union Carbide Corporation will now discuss the results of AMC's preliminary analysis.

Radon from Uranium Tailings

Various authorities give the total radon release from natural sources (soils and rock) in the United States as approximately 120,000,000 to 130,000,000 curies per year. Releases from man's activities are much less. For example, the largest man-made contribution, agriculture, adds about 3,000,000 curies per year. The amount of radon released from uranium mill tailings is generally taken to be in the range of 100,000 to 300,000 curies per year.

The specific activity of radon-222 is such that 1 gram of radon contains about 154,000 curies. The total amount of radon released per year by all mill tailings, assuming no stabilization, is thus less than 2 grams, or about 1/20th of an ounce, of material. In view of the small amount of radon gas that is released over the year from the tailings piles, it is not surprising that within a distance of 1/4 to 1/2 mile, it is readily dispersed and cannot be detected.

A more detailed calculation follows:

The area of the inactive uranium mill tailings piles and the commingled tailings piles is 3362 acres. Each acre contains 4056 square meters; therefore, the surface area of these tailings piles is some 1.36×10^7 M^2.

The nominal Rn^{222} emanation rate from the tailings piles is 640 pCi/M^2-sec. For these piles, this results in an annual emanation of 275,000 curies of Rn^{222}, i.e.,

$$Ci/yr = 640\ pCi/M^2\text{-sec} \times 1.36 \times 10^7\ M^2 \times 31.5 \times 10^6\ sec/yr \times 10^{-12}\ Ci/pCi$$

$$= 275{,}000\ curies/yr$$

The specific activity of Rn^{222} is 1.54×10^5 Ci/g; therefore, 275,000 curies equates to 1.75 grams.

One gram is equivalent to 0.03527 ounces; therefore, 1.78 grams of Rn^{222} equates to 0.063 ounces or 6/100ths of an ounce, which is about 1/20th of an ounce.