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LBP-86-18

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before Administrative Judges:

John H Frye, III, Chairman
Dr. James H. Carpenter
Dr. Jerry R. Kline

In the Matter of	Docket No. 40-2061-SC
KERR-McGEE CHEMICAL CORPORATION	ASLBP No. 84-502-01-SC
(Kress Creek Decontamination)	June 19, 1986

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INITIAL DECISION

(Order to Show Cause)

Appearances

Stephen H. Lewis, Deputy Assistant Chief Hearing Counsel, and Henry J. McGurren and Mary E. Wagner, Counsel, Bethesda, Maryland, for the United States Nuclear Regulatory Commission Staff.

Peter J. Nickles, Richard A. Neserve, and David P. King, Washington, D.C., for the Kerr-McGee Chemical Corporation.

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Introduction

This proceeding was initiated by an Order to Show Cause (Order) issued by NRC Staff to Kerr-McGee Chemical Corporation (Kerr-McGee) on March 2, 1984.[1] On March 12, Kerr-McGee filed an answer to the Order and demanded a hearing. On June 28, the Commission referred this matter to the Chairman of the Atomic Safety and Licensing Board Panel to appoint an atomic safety and licensing board to conduct any necessary proceedings under 10 C.F.R. Part 2, Subpart A, and to consider and decide whether, on the basis of the allegations of §§ II and III of the Order, Kerr-McGee should be required to take the actions specified in § IV.[2]

The Order to Show Cause

Kerr-McGee holds a license authorizing possession of unlimited amounts of thorium at its West Chicago Rare Earths Facility. This facility ceased operations in December 1973. Section II of the Order alleges that a portion of the wastes from that site have been disposed of by discharge to Kress Creek and thence to the West Branch of the

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1 See 49 Fed. Reg. 9288, March 12, 1984.

2 On June 29, 1984, this Board was established by the Chairman, Atomic Safety and Licensing Board Panel (49 Fed. Reg. 27863, July 6, 1984), and reconstituted on February 4, 1986 (51 Fed. Reg. 5007, February 10, 1986).

DuPage River, either by a storm sewer which enters the creek 0.7 Km south of the site, or by a drainage ditch. Section II notes that from this point the creek flows for about two kilometers to its confluence with the West Branch at the DuPage River. Section II goes on to recite the history of the discovery of the contamination of the creek and river.[3]

Section III begins by noting that a comprehensive radiological survey has been performed at the instance of the Staff. The survey was designed to determine direct radiation levels and the depth distribution of the contamination in the stream beds and along the banks. Section III alleges that the survey revealed the presence of thorium and its daughters essentially in secular equilibrium. It summarizes the survey results and notes that many of the highest concentrations were found in areas near the storm sewer outfall. This section concludes by alleging that the contamination exceeds the standards promulgated by the U.S. Environmental Protection Agency (EPA) under the Uranium Mill Tailings and Radiation Control Act (UMTRCA) for unrestricted use of areas on which thorium processing wastes have been disposed (40 C.F.R. Part 192, Subparts B and E)[4], that NRC is responsible for enforcing these standards, and that cleanup is required.

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3 For convenience, we will refer to both these streams as Kress Creek or the Creek.

4 We will refer to this standard as the radium-in-soil standard.

Section IV required Kerr-McGee to Show Cause why it should not be required to prepare a remedial action plan for the cleanup and disposal of the contaminated material and expeditiously execute the plan following NRC approval. There is no allegation in the Order of any violation of a regulation or license condition. Kerr-McGee responded to the Order with an Answer (and subsequently an amended answer) and a Demand for Hearing.[5]

Two petitions to intervene were received, one from the People of the State of Illinois and Illinois Department of Nuclear Safety (collectively referred to as "the People") and the other from the Nicheren Shoshu Temple (NST).[6] Kerr-McGee did not object to the petitions.[7] The NRC Staff asserted[8] that both were late filed, but concluded that after balancing the five factors set out in 10 C.F.R. § 2.714(a) for nontimely intervention petitions, they should be granted. We concluded that the petitions were timely, that each party had

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5 Answer and Demand for Hearing of March 19, 1984; Amended Answer of October 10, 1984.

6 People of the State of Illinois Petition to Intervene, July 10, 1984; Petition for Leave to Intervene, July 11, 1984.

7 Answer by Kerr McGee Chemical Corporation to the People of the State of Illinois Petition for Leave to Intervene, July 25, 1984; Answer by Kerr-McGee Corporation to the Petition for Leave to Intervene filed by Nicheren Shoshu Temple, July 25, 1984.

8 NRC Staff Response to Petitions of the Nicheren Shoshu Temple and the People of the State of Illinois for Leave to Intervene, July 30, 1984, at 5-9.

standing, and that each had submitted at least one acceptable contention. We granted party status to the People and NST at the first prehearing conference, held in Chicago, August 22, 1984.[9]

The People filed six contentions. Contention 1 raised the possibility that chemical pollutants may exist in Kress Creek which should be considered in any cleanup plan. Contention 6 was duplicative of the Order. Contention 2 through 5 raised matters concerning disposal of the material excavated from the Creek. Contentions 1 and 6 were admitted, while a ruling on Contentions 2 through 5 was withheld pending a determination that Kerr-McGee must prepare a cleanup plan and pending a resolution of the dispute concerning disposition of the tailings located at the West Chicago site.[10]

We dismissed Contentions 1 and 6 in LBP-85-48, 22 NRC 843 (1985) as a sanction for failure of the People to comply with our discovery orders contained in LBP-85-38, 22 NRC 604 (1985). In LBP-85-48, we noted the agreement between counsel for Staff and the People that these contentions would not add anything to the hearing. Our action did not dismiss the People as a party and they were free to participate in the hearing. However, they chose not to do so.

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9 Tr. 25-26; Unpublished Prehearing Conference Memorandum and Order of September 7, 1984.

10 Unpublished Memorandum and Order of October 22, 1984.

The Temple, whose property lies along Kress Creek, filed eight contentions. All of these except Contention 7 were admitted.[11] On April 1, 1985, the Temple withdrew from this proceeding.

The hearing took place at West Chicago, Illinois on April 28 and in Chicago on April 29 and 30, 1986. We heard limited appearance statements from the City of West Chicago in opposition to the movement of any contaminated materials into the City (Tr. 316-18), from the DuPage County Forest Preserve District asking for information with regard to the contamination (Tr. 318-20),[12] and from the Director of the West Chicago Parks District expressing his desire to know whether the material in the creek poses a hazard (Tr. 342-43). Although two or three persons who live along the creek were present and invited to state their views, they did not do so (Tr. 342).

Board Jurisdiction

In the initial stages of this proceeding, the parties raised the

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11 Unpublished Memorandum and Order of October 22, 1984.

12 On May 13, 1984, the president of the DuPage County Forest Preserve Commission announced that he was closing a one-mile stretch of the Blackwell Forest Preserve along the DuPage River because of uncertainty surrounding the contamination in the river banks and sediment. PNO-III-85-45, May 14, 1986.

question of NRC jurisdiction in this matter.[13] On November 27, 1984, Staff, the People and NST (Proponents) jointly filed a motion[14] requesting the disposition of several averments contained in Kerr-McGee's amended answer. These parties asserted the averments raised affirmative defenses to the Order challenging Staff's authority to take the enforcement action.

The averments which Proponents wished dismissed state:

> 10. No such Order may be issued by the NRC without a finding of a specific significant risk of health, safety or environmental harm.
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> 11. No such Order may be issued without a complete analysis of the actual risk to the health and safety of the public of compliance with such an Order.
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> 12. No such Order may be issued without a complete analysis of the risk of harm to the environment from compliance with such Order.
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> 13. No such Order may be issued without a complete analysis of the costs and benefits of remedial action, including the impacts upon the communities and individuals affected by compliance with such an Order.

Kerr-McGee argued that the averments raised jurisdictional matters which must be addressed by Staff if the Order was to be enforced.

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13 Unpublished Prehearing Conference Memorandum and Order, September 7, 1984, at 4-5.

14 Joint Motion For Disposition of Averments, November 29, 1984.

Kerr-McGee also asserted that the relief sought -- disposition of the averments as a matter of law -- was inappropriate because the averments presented mixed questions of law and fact.

We denied the Proponent's motion without prejudice to the filing of properly supported motions for summary disposition.[15] There, we recognized the disparate views held by the parties with respect to the matters which must be proven for the Board to enforce the Order. We requested briefs from the parties on the question of what facts must be shown at hearing for Staff to prevail, and urged the parties to focus on the applicable regulatory standards and any circumstances unique to the Kress Creek situation which might militate against the application of those standards.[16]

In view of our ultimate conclusions that the radium-in-soil standard is not appropriate for application in this situation and that no hazardous condition or threat to health has been demonstrated on this record, we need not recite in detail the controversy on this point. However, it is important to note that Staff conceded, in response to Kerr-McGee's position that UMTRCA could not be retroactively applied, that the radium-in-soil standard was not legally binding in this situation. Staff then based its jurisdictional argument on §§ 62, 63, and 161(b) of the Atomic Energy Act, and argued that the radium-in-soil

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15 Unpublished Memorandum and Order, December 28, 1984.

16 Id.

standard, although not legally binding, was nonetheless appropriate and should be applied.[17]

It is also important to note that our jurisdiction does not depend on whether the material in Kress Creek may properly be classified as source or byproduct material. Section 161(b), on which Staff relies, states:

> In the performance of its functions the Commission is authorized to establish by rule, regulation, or order, such standards and instructions to govern the possession and use of special nuclear material, source material, and byproduct material as the Commission may deem necessary or desirable to promote the common defense and security or to protect health or to minimize danger to life or property.

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17 With regard to the allegations contained in the Order, Proponents and Kerr-McGee agreed that the burden of going forward would be borne by Proponents. There was strong disagreement, however, about whether Kerr-McGee's averments should be characterized as affirmative defenses on which Kerr-McGee must present evidence or as jurisdictional issues on which Proponents must bear the burden. The Board indicated that it did not find authority to support Kerr-McGee's view that a specific, significant risk, something more than a hazardous condition to the health and safety of the public or to the environment, must be found if the order is to be enforced. Thus, the Board ruled that Kerr-McGee was to bear the burden of going forward with a showing to sustain its position on this averment. Second Prehearing Conference Memorandum and Order, February 7, 1985, at 9.

The averments posed a legal issue concerning the EPA radium-in-soil standards advanced by the Staff. Kerr-McGee contended that cleanup to those standards could be enforced, if at all, only after the Board had engaged in a balancing of costs and benefits, an analysis not required under § 161(b) of the Atomic Energy Act. Staff's position was predicated upon its view that a cost-benefit analysis by the Board was unwarranted because EPA had already analyzed those considerations in the course of promulgating the radium-in-soil standard. We find it unnecessary to rule on the above controversy because Staff has failed to show that the radium-in-soil standard is appropriate in this situation.

On its face, § 161(b) restricts the Commission's authority to special nuclear, source, and byproduct material. Kerr-McGee is a source material licensee subject to the regulations contained in 10 C.F.R. Part 40. UMTRCA extended NRC's jurisdiction to mill tailings, the waste product of the West Chicago facility which probably contaminated the creek, by including them in the definition of byproduct material. Given that UMTRCA was conceded to be inapplicable, a question arose concerning NRC jurisdiction with regard to the material in Kress Creek. At the prehearing conference, Staff counsel opined that the material in Kress Creek might be source material, and Staff addressed some testimony to this point at the hearing. This testimony was undoubtedly in response to our statement in our March 22, 1985, Memorandum and Order that "... Staff must show that the contamination which it wishes cleaned up is properly classified as source material ...." Kerr-McGee regards this statement as dictum. Kerr-McGee's Post Hearing Submission, at 18 n.1. Whether dictum or not, we believe that this statement was in error and that, as will be seen, jurisdiction exists regardless whether the material may properly be classified as source material. Thus we find it unnecessary to address Staff's testimony that the material is source material.

We regard our statement that Staff must show that the material is source material to be in error for the following reasons. Under 10 C.F.R. § 20.2, Part 20 is applicable to Part 40 licensees. Section 20.3(a)(13) defines "radioactive material" to include such material whether or not subject to the Commission's regulatory authority.

Section 20.105(a) requires licensees to restrict their possession and use of radioactive materials so as to ensure that it will be unlikely that any individual member of the public will receive a dose of more than 0.5 rem per year. And § 20.1(c) requires licenses to make every reasonable effort to restrict releases of radioactive materials to levels which are as low as reasonably achievable. Clearly, this regulatory scheme illustrates that jurisdiction exists to regulate radiation hazards caused by a licensee whether or not the hazard results from materials which fall within one of the three categories stated in § 161(b).[18]

Kerr-McGee contests the proposition that the material in the creek came from its West Chicago facility and thus is its responsibility. However, the uncontradicted evidence indicates that the West Chicago Rare Earths Facility is the only thorium processing plant within 50 miles of Kress Creek. This severely narrows the possible places from which the material may have originated. Kerr-McGee's efforts to establish other possible sources (e.g., spillage from railroad cars at the railroad crossing of Kress Creek close to the storm sewer outfall)

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18 Kerr-McGee agrees that ". . . the NRC has authority to issue a customized order directed at a licensee regarding the offsite release of materials that are not themselves source materials." Post Hearing Submission at p. 19. While Kerr-McGee does not contest jurisdiction provided Staff demonstrates that the material along the creek accidentally escaped from the site, it does recognize that there are limitations on the Commission's authority to regulate mill tailings prior to the passage of UMTRCA. Id. p. 20.

are pure speculation. While Staff's testimony on possible pathways the material might have followed into Kress Creek is also speculative, in this case we believe the thing speaks for itself. While recognizing the speculative nature of the testimony on this point, we find that the material in Kress Creek came from the West Chicago facility while it was licensed under the Atomic Energy Act and decide this controversy on the merits of the hazard posed by that material. Findings 1 through 21 support this conclusion.

The Staff's Proposed Criteria for Cleanup

The Order states:

> the NRC Staff concludes that cleanup of the offsite vicinity properties along Kress Creek and the DuPage River is required and that the following levels of contamination specified in EPA standards are to be used as criteria for the offsite properties:
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> 1. Five picocuries of radium per gram of soil (pCi/g), averaged over the first 15 centimeters (cm) below the surface, and
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> 2. Fifteen pCi/g averaged over 15 cm thick layers more than 15 cm below the surface. The specified levels of contamination may be averaged over areas of 100 square meters.[19]

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19 Kerr-McGee notes that this statement should have specified radium-228 above background. Staff witnesses Cool and Shum so specified in their testimony (Tr. 469-70), and we consider the standard in that light.

In view of Staff's concession that EPA's radium-in-soil standard may not be applied retroactively, we must decide whether it is appropriate guidance for the specific problem posed by the Kress Creek radiological contamination.

We begin by noting the nature of the hazard which Staff perceives. Staff testified that the principal exposure pathways from thorium and its daughters are direct irradiation and inhalation.[20] Staff counsel has indicated that the principal hazard to the present residents of the Kress Creek area is from gamma doses.[21] Staff's reply findings indicate that the possibility that houses might be built on the existing contamination many years in the future may not be overlooked,[22] although Staff's proposed findings indicate that the radium-in-soil standard was not designed to protect against that possibility.[23]

Staff relied upon EPA's statement that the radium-in-soil standard is appropriate for the cleanup of offsite vicinity properties. Staff's justification for the use of the radium-in-soil standard is set out below.

> Q8. Has USEPA stated a view as to the appropriateness of applying the 5 and 15 pCi/g standards to cleanup of offsite properties in the vicinity of Title II sites?

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20 Shum and Cool ff. Tr. 425 at 6.

21 Kerr-McGee Ex. 12; Tr. 344.

22 Staff Reply Findings, p. 12.

23 Staff Proposed Finding 110, p. 49.

> A8. Yes. USEPA has stated in its "Final Environmental Impact Statement for Standards for the Control of Byproduct Materials from Uranium Ore Processing" (FEIS), which was prepared in support of the issuance of 40 C.F.R. Part 192, Subparts D and E, that:
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> > We believe that the Standards (40 CFR Part 192, Subpart B) we have already published for the off-site cleanup program for inactive mills under Title I of UMTRCA would be suitable for application to off-site contamination from active mills.
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> FEIS, Volume II, Page A.1-3. See also pp. A.5-36 and -37. This would include offsite thorium, as well as uranium, contamination, since the numerical standards are the same for both chains. FEIS, Vol I, Appendix G; Vol. II, p. B.3-2.[24]

Page B.3-2 of Vol. II contains responses to individual comments on EPA's draft impact statement and consequently does not merit great weight. However, it is evident from this reference that EPA was concerned with radon emanating from a tailings pile, not with the hazard posed by contamination of property in the vicinity of the pile, such as the problem posed by Kress Creek.

The response to Comment 7 - which states that the risks from radon-220 (thoron) emissions from a tailings pile are comparable to those from radon-222 emissions when the much larger source term from thoron is taken into account and which references Appendix G of the FEIS - makes clear that USEPA was focussing on a hypothetical tailings pile and the need for thoron flux reductions from such a pile. Similarly,

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[24] Shum and Cool ff. Tr. 425, pp. 4-5.

review of Vol. 1, Appendix G, shows that USEPA was focussed on demonstrating the need for thoron flux reduction from a hypothetical thorium mill tailings pile. In the Kress Creek situation, there is no tailings pile and we do not find the staff reference to be helpful. We do not find any mention of the radium-in-soil standard in Appendix G.[25]

However, in Appendix G, section G.4, there is a brief discussion of gamma radiation from tailings. It states that individual doses must be assessed on a case-by-case basis because details on shielding and distance are critical in the calculation. This is directly pertinent to the Kress Creek situation. Moreover, §G.4 also makes the point that for equal concentrations, the gamma flux density and associated absorbed dose rate for the thorium series is approximately fifty percent greater than for the uranium series. If a radium-in-soil standard were to be used to protect the public from gamma radiation, the difference between the thorium and uranium decay series would lead to two different standards for the two <u>different</u> materials. Permissible concentrations of thorium would be less than permissible concentrations of uranium.[26]

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25 For this reason we do not agree with Staff that, in promulgating the radium-in-soil standard, USEPA balanced costs and benefits for radium-228.

26 The spotty nature of the Kress Creek contamination results in low gamma doses. If this contamination were more widely distributed over the Kress Creek area, occupancy factors and consequently dose would increase. Nonetheless, a radium-in-soil standard is not an appropriate way to regulate gamma doses because the latter are easily measurable. A gamma dose limit is more straightforward.

However, it is clear that the radium-in-soil standard was not promulgated by the USEPA to control gamma exposure rates but rather to limit the inhalation exposure of people in houses to radon-222 and its daughters as described on pages 9-14 to 9-16 of the FEIS. The specification in the standard that the contamination levels should be averaged over 100 square meters reflects this fact.

When the risk to the public from possible inhalation of daughters of radium-226 (uranium series) is compared to possible inhalation of daughters of radium-228 (thorium series), a substantial quantitative difference is evident. The health risk resulting from exposure to a given concentration in air of thoron and its daughters is about one-third that of radon and its daughters. FEIS at G-8. Furthermore, we accept Kerr-McGee's testimony (Auxier, et al., Table III-1) that if a house were built on soil containing equal concentrations of radium-228 and radium-226, the concentration of thoron and its daughters in the house would be 30 times smaller than the concentration of radon and its daughters. Thus, when the differing half-lives of thoron and radon are taken into account, the overall inhalation risk resulting from building a house on soil containing thorium and radium-228 is approximately 90 fold smaller than the risk from building on soil containing the same activity of uranium and radium-226.

If a "radium-in-soil" standard were appropriate for protecting the public in the Kress Creek situation, the above quantitative differences between the thorium and uranium series could be considered. However, we see no need to do so. Staff counsel has stated that external gamma

radiation is the primary mode by which members of the community using the Creek area could receive additional radiation exposures,[27] and Staff does not contest Kerr-McGee's proposed findings 133, 135-140 which assert that the risk posed by inhalation of thoron emanating from Kress Creek (either outdoors or within a hypothetical house built over a concentration of 110 pCi/g) is inconsequential. The Kerr-McGee testimony on risks shows that direct gamma exposure is the predominant pathway in the dose assessment. Auxier, et al., ff. Tr. 591 at pp. 20-21. We agree that any risk to the public posed by Kress Creek results from direct gamma exposures. A "radium-in-soil" standard is superfluous and inappropriate. In the next section, we examine this risk against a gamma exposure standard, based on Part 20, of 0.1 rem per year above the natural ambient background.

The use of a 0.1 rem per year criterion provides a greater degree of public health protection from direct gamma exposure than the EPA radium-in-soil standard. On pages 9-16 of the FEIS, EPA estimated the residual risk of fatal lung cancer under the radium-in-soil standard as two in 100 for lifetime exposure resulting from living in a house built on soil contaminated with uranium. The Kerr-McGee testimony (Auxier, et al., at p. 23) quotes the International Commission on Radiation Protection and the NRC as to risk from ionizing radiation at 1.65×10^{-4} per rem. The 0.1 rem per year criterion corresponds to a lifetime (70

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27 Note 19, supra.

year) cancer fatality risk of approximately 1 in 1000. The use of a 0.1 rem per year exposure limit provides a greater degree of public health protection than the radium-in-soil standard by a factor of approximately 20 where the hazard comes from gamma radiation.

For all of the foregoing reasons, we reject the radium-in-soil standard as appropriate to protect health in the circumstances of this case. Findings 65 through 76 support this result. However, we reach no conclusion with regard to the appropriateness of this standard in dealing with a different situation.

Part 20 Criteria for Cleanup

We have determined that the standards promulgated by EPA under UMTRCA are not appropriate to govern a cleanup at Kress Creek, and that Part 20 applies. Therefore, we believe it appropriate to review Part 20 to determine whether, under its standards, Kress Creek may present a hazard. We do so recognizing that Part 20 standards have not been advocated by Staff despite our calling attention to them.

In our unpublished Memorandum and Order of March 22, 1985, we noted that, in view of Staff's concession that UMTRCA was not legally applicable, the radium-in-soil standard was not immune to attack under 10 C.F.R. § 2.758. We went on to state that ". . . we expect the proponents to justify the application of these standards to the single, unique situation at Kress Creek . . ., as opposed to the application of

other standards (for example, the standards found on 10 C.F.R. Part 20)."

We recognize that Staff's choice not to advocate Part 20 standards would inhibit us from granting relief based on them. Nonetheless, Kerr-McGee did address them in its testimony, and we have concluded that they are not only applicable, but more appropriate to assess the Kress Creek risk than the radium-in-soil standard. Consequently, we believe it advisable to address them.

We began by noting that the § 20.105(a) sets down the proposition that:

> The Commission will approve the proposed limits [on levels of radiation in unrestricted areas] if the applicant demonstrates that the proposed limits are not likely to cause any individual to receive a dose to the whole body in any period of one calendar year in excess of 0.5 rem.

The 0.5 rem standard is based on the recommendation of the Federal Radiation Council. The National Council on Radiation Protection and Measurements and the International Commission on Radiological Protection made parallel recommendations. The Commission has noted that the 0.5 rem standard gives

> . . . appropriate consideration to the overall requirements of health protection and the beneficial use of radiation and atomic energy. The Commission believes that the record clearly indicates that any biological effects that might occur at the low levels of these standards have such low probability of occurrence that they would escape detection by present-day methods of observation and measurement.[28]

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28 Rulemaking Hearing - Numerical Guides for Design Objectives and (Footnote Continued)

Thus 0.5 rem per year constitutes a level of exposure which is unlikely to have any visible effect on the person exposed to it.

The 0.5 rem exposure limitation is a limitation on all exposures (except natural background and medical exposures).[29] Because it must be assumed that any individual will experience doses from multiple sources, the exposure from any single source of gamma radiation, such as Kress Creek, must be less than 0.5 rem per year.

The Commission has proposed to adopt a new Part 20. That proposal furnishes guidance as to how much less than 0.5 rem per year any exposure from an individual source should be. Noting that it is impractical if not impossible to accurately determine the precise total dose received by any individual member of the public, proposed § 20.303(a) establishes a reference level of 0.1 rem. If a licensee can demonstrate that its operations will not result in a dose to any individual in excess of this amount, it will be deemed to be in compliance with the 0.5 rem limitation.

We believe the 0.1 rem standard to be appropriate for Kress Creek. Section 161(b) authorizes orders necessary to "protect health." Similarly, § 2.202(a) addresses potentially hazardous situations. Part 20 establishes that no individual member of the public should receive a

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(Footnote Continued)
Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water Cooled Nuclear Power Reactor Effluents, CLI-75-5, 1 NRC 277, 280 (1975).

29 Id.

dose at more than 0.5 rem in any calendar year. In order to ensure that the 0.5 rem standard will not be exceeded from all sources, proposed Part 20 establishes 0.1 rem as a dose level for individual sources which may not be exceeded without justification. Based on the above, we believe that 0.1 rem represents a reasonable limitation on dose resulting from the material in the Creek area which is necessary to protect health.

The 0.1 Rem Limitation Applied to Kress Creek

The significance of any particular, localized area of elevated gamma exposure rate will depend on the time period that people might be reasonably expected to be in that area, i.e., to occupy that particular locale. The health risk to an individual depends on the time integrated or summed exposures. Thus, in examining the observed gamma radiation distributions in the Kress Creek area to determine the extent to which a hazard may exist, occupancy factors are of paramount importance because anticipated radiation doses are directly proportional to anticipated time of exposure.

Staff responded to our question[30] that occupancy factors should be considered in connection with Kress Creek, but did not offer an opinion concerning the appropriate occupancy factors that would apply to the

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30 See Unpublished Memorandum and Order of May 8, 1985.

Kress Creek properties, other than to note that the USEPA used a 75 percent occupancy factor for indoor exposure in the FEIS, Vol.1, p. 5-2. Cool/Shum testimony at 12.

The Kerr-McGee testimony (Auxier, et al., at 8-10) cites a report by N.A. Frigerio, T.J. Larson and R.S. Stowe ("Thorium Residuals in West Chicago, Illinois," NUREG/CR-0413, ANAL/ES-67, 1978; Kerr-McGee Ex. 1)) as a basis for estimating an occupancy time of 200 hr/yr for "lawns and gardens of a sort experiencing some residential occupancy." The Board perceives this estimate of the outdoor exposure time period to be debatable. We note that Frigerio, et al., did not estimate occupancy factors for the Kress Creek properties, but rather only made estimates for a number of locations in the City of West Chicago.

Kerr-McGee quotes Frigerio, et al., as noting "that occupancy is inhibited simply by the relatively high fraction in inclement weather in this area." Frigerio, et al., p. 9. The term "relatively high" is subjective and provides no basis on which to judge occupancy. We note that, even if the weather is unsuitable for outdoor activities 50 percent of the time, outdoor occupancy might easily be 540 hours per year and we question whether the Frigerio, et al., estimate is sound.

Also, we consider it possible that outdoor occupancy and exposure might not be the primary risk consideration for the Kress Creek situation. As Dr. Chambers, a Kerr-McGee witness, testified "one could postulate that there might be some external gamma radiation associated with time spent indoors." Tr. 685. Shielding or exposure reduction for the gamma radiation fields caused by the Kress Creek materials has not

been measured as a part of the record in this proceeding. For frame houses, the shielding might be roughly 10 percent so that the indoor exposure rate may not be much smaller than the outdoor exposure rate.[31] When outdoor occupancy of roughly 540 hours per year or 6 percent of the year is compared with 75 percent indoor occupancy (6570 hours), it can be seen that indoor exposure rates 10 times smaller than outdoor rates would lead to dominance in the total exposure sum for the indoor exposure.

The 0.1 rem per year criterion would correspond to a 11 microrem per hour increment above background, if continuous, year-long exposure occurred. If the background exposure is taken as 9 microrem per hour, indoor exposure with 75 percent occupancy should be limited to 24 microrem per hour to meet the 0.1 rem criterion. Review of the ORAU report shows that there are only a few residential properties where the exposure rate borders on 24 microrem per hour. Outdoor exposure rates measured by ORAU are well below the 0.1 rem criterion on any reasonable occupancy rate. Findings 77 through 83 support these conclusions, while Findings 22 through 29 describe Kress Creek and Findings 30 through 64 describe the radiological surveys and their results.

Because no party has addressed § 20.1(c) which admonishes that doses should be "as low as is reasonably achievable," we do not consider

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31 See Long Island Lighting Company (Shoreham Nuclear Power Station), LBP-85-21 NRC 644, p. 773 (1985).

whether the gamma doses resulting from Kress Creek meet this standard. However, our review of the record indicates that there are a few limited areas of relatively high gamma exposure rates which might be cleaned up with a minimum of expense and disruption.

Furthermore, no party has addressed the questions of the size of the population which might be exposed to gamma radiation emanating from Kress Creek or the realistic (as opposed to maximum acceptable) doses that that population might receive. Nor has any party addressed the costs and disruption incident to a cleanup to ALARA standards.[32] Therefore no balancing is possible under § 20.1(c).

Because of the above, we express no opinion whether, had Staff chosen to proceed under Part 20, some relief might have been appropriate. This record does not foreclose that possibility.

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32 Kerr-McGee has submitted uncontroverted testimony on the economic and environmental impact , as well as industrial risks, of cleanup to the radium-in-soil standard.

FINDINGS OF FACT

Background

1. The Lindsay Light Company began processing thorium ores at West Chicago, Illinois, in the 1930s. In 1958, American Potash & Chemical Corporation purchased the Lindsay Light Company, including the West Chicago site. In 1967, Kerr-McGee acquired the site through a merger with American Potash. Rare Earths FES, at xi.

2. The Rare Earths facility consists of three portions: a factory site (8 acres), where processing occurred; a disposal site (27 acres); and an intermediate site (8.4 acres), which is between the factory and disposal site and has not been used for site operations. Horn et al. Testimony, at 3.

3. The disposal site currently contains two major solid waste residue piles and five disposal ponds. Horn et al. Testimony, at 5-6.

4. The railroad right-of-way runs parallel to and just west of the west boundary of the entire site. The right-of-way is markedly elevated above the surrounding topography. Horn et al. Testimony, at 4-5.

5. The facility operated from 1932 to 1973. Initially, the facility primarily produced thorium nitrate for use in incandescent light mantles. The facility also produced rare earths materials for a variety of industrial uses including polishes, chemical manufacture, catalysts, and television phosphors. Horn Testimony, at 8. A major

portion of the activities at the site were related to the production of thorium pursuant to government contracts. Rare Earths FES, App. H, at H-4.

6. With the passage of the Atomic Energy Act of 1954, production of thorium at the facility became subject to federal regulation. At all times since May 1, 1956, the facility has been licensed by the Atomic Energy Commission or its successor, the Nuclear Regulatory Commission. Rare Earths FES, at xi.

7. The process used for thorium and rare earths production at the facility produced two waste materials. These wastes were deposited on site. One resulted from the ore digestion process and was a solid sand-like residue. The other was composed of liquid wastes from a number of processes and contained dissolved salts and suspended solids. The solids settled out on the bottoms of the facility's sumps and percolation ponds. These sediments were periodically dredged from the ponds and sumps and placed on a sludge pile near the ponds. Both these waste materials, which contain quantities of thorium and thorium daughter products, remain on the disposal site pending resolution of Kerr-McGee Chemical Corp. (West Chicago Rare Earths Facility), Docket No. 40-2061-ML. Horn et al. Testimony, at 10.

8. A storm sewer runs to the east of the factory site (under Factory Street), jogs west under the intermediate site, and then continues south under the west edge of the disposal site just inside its western boundary. It then proceeds under property not owned by

Kerr-McGee to its discharge point into Kress Creek. Horn et al. Testimony, at 4, 12.

9. The storm sewer outfall is approximately 400 meters south of the southwest corner of the disposal site. Kress Creek flows generally south from that outfall for approximately 2,000 meters to its confluence with the West Branch of the DuPage River. Horn et al. Testimony, at 5-6; Staff Ex. 1, p. 2.

10. Neither Kerr-McGee nor its predecessors have ever been cited for any violation relating to the discharge of thorium into Kress Creek. Tr. 409.

Cause of the Contamination

11. The Staff believes that contamination may have reached the Creek through the storm sewer. Staff suggests that the material could have reached the sewer by (1) drainage from roof or yard drains, (2) overflow of process liquids from an on-site sump, (3) erosion or physical displacement from the tailings pile to a manhole on the disposal site, or (4) overflow or drainage from the percolation ponds. Horn et al. Testimony, at 15-18.

12. The Staff relies on documentary evidence for its theories of how the thorium bearing material reached its present location on or in Kress Creek. Horn et al. Testimony, at 15-18; Tr. 365, 373, 380. No one on the Staff has personal knowledge of how materials got from the site to the Creek. Tr. 358.

13. The amount of material that may have come from roof drains cannot, by itself, explain the volume of material in the Creek. Tr. 365.

14. The specific location of the yard drain or drains and the nature of any connections to the sewer are subject to some uncertainty based on documentary records. Tr. 370-71. However, the NRC Staff has personally observed one yard drain on the Kerr-McGee site. Tr. 370-71; 410.

15. Liquid process wastes met the radiological limits for discharge to a sanitary sewer established by AEC and NRC regulations according to documentary records of 1972. Tr. 380, 391-92. However, thorium can concentrate in the environment. Tr. 410.

16. Radiological contamination of the groundwater under the site, which would be the consequence of drainage from the percolation ponds, has not been shown. Tr. 405-406. The Staff nevertheless believes that this is a possible pathway for thorium materials to have entered the storm sewer leading to Kress Creek. Tr. 411.

17. Movement of thorium-containing materials from the tailings pile to the sewer by way of a nearby manhole is a possible pathway for entry of material into the storm sewer outfall. However, a berm, which was constructed in 1957 and is located over the storm sewer, directs runoff from the waste residue piles toward a depression to the south. Resp. Ex. 3; Horn et al. Testimony, at 4. Runoff water forms a pond to the south of the manhole. Tr. 397-98. The manhole is covered by a solid plate that has never been known to have been removed. Tr. 394-96.

18. A railroad crosses over Kress Creek in the vicinity of the storm sewer outfall. Kerr-McGee suggests the possibility that contamination entered the Creek as a result of a release from trains bringing ores to the site, but offered no direct evidence to substantiate this. No records of spills of thorium ores into the Creek from trains exist. Tr. 408.

19. Material that fell off trucks may have washed into the West Chicago storm sewers and been deposited in Kress Creek. Tr. 414, 416-17. This material could have been coming to or leaving the site. Tr. 418. The Staff has no evidence indicating this. Tr. 417.

20. There is no facility within 50 miles of the Kerr-McGee site that now processes or that ever processed thorium bearing materials. Horn et al., at 19-20.

21. The quantity of solid waste (tailings plus pond sediments) produced in the West Chicago plant was approximately proportional to the ore fed to the process. Losses to residues were 20 to 25 percent of total oxide input. The plant processed 10,000 tons per year of monazite sands during peak production years between 1954 and 1958, about 5000 to 6000 tons per year between 1958 and 1963, and about 2000 to 2500 tons per year before 1954 and after 1963. The ore fed to the process from 1954-1973 was about 77 percent of the total ore used from 1936-1973. The solid wastes on the disposal site are predominantly from operations during the period after the plant was licensed by the Atomic Energy Commission. The contamination along the Creek, in part, occurred during

the period the Rare Earths facility operated under AEC license. Horn et al. Testimony, pp. 14-15; Staff Exhibit 4, at 13, 31.

Kress Creek

22. Kress Creek is a small, spring-fed flood plain stream. It has major surges during storms. Tr. 575. Its bottom is relatively stable and its sediments are stabilized. Tr. 576.

23. The Creek floods frequently during heavy rainfall and spring flows. Kerr-McGee Risks Testimony, at 16; Tr. 583, 584. The apparent flood control area above the storm sewer may minimize the amount of flooding that occurs. Tr. 584.

24. The land in the immediate vicinity of the storm sewer outfall is predominantly a thicket. This thicket continues for some 200 meters downstream from the outfall. Salamon Testimony, at 8, Ex. A.

25. The next 600 meters downstream consist of a residential community. Houses are typically about 30 meters from the Creek with landscaped backyards that abut the banks. Salamon Testimony, at 8, Ex. A.

26. Except for the Nichiren Shoshu Temple (NST) and a few houses near the Creek's confluence with the River, there are no other residential areas close to the Creek between the storm sewer outfall and the River. Salamon Testimony, at 8, Ex. A. Staff Ex. 1 (figures 4 through 7) shows the location of houses in relation to the creek.

27. South of the residential area, there is a park that is owned and operated by the West Chicago Park District. The park consists predominately of open fields, shrubs, and occasional tree stands. The park borders the creek for approximately 800 meters. Salamon Testimony, at 9, Ex. A.

28. South of the park, the creek traverses undeveloped pastureland, floodplain forest, open field, and the NST property. The creek proceeds through this area for some 800 meters. This area includes clover, shrubs, woods, and woodland managed for hunting by DuPage County. Salamon Testimony, at 9, Ex. A, letter of August 6, 1984 to Honorable John H Frye, III from Kelley, Drye, & Warren..

29. Approximately 60% of the Creek from the sewer outfall to the River passes through undeveloped field and forest. About 35% of the Creek from the outfall to the River is bounded by mature forest. Salamon Testimony, at 9, Tr. 574.

Radiological Surveys

30. In 1974 Kerr-McGee began cleanup activities to decommission its West Chicago facility. At the request of the NRC, the Argonne National Laboratory conducted a radiological evaluation of thorium residues in the West Chicago area. The study of the Kress Creek region consisted primarily of direct radiation measurements between the sewer outfall and the River. Staff Ex. 1, at 1 (1984).

31. A 1977 aerial radiological survey by EG & G -- together with soil and sediment samples collected in 1980 by the EPA -- confirmed the presence of thorium in soil along the Creek. EPA found that the primary radionuclides in the soil were Th-232 and Th-228 in essentially secular equilibrium. Staff Ex. 1, at 1.

32. On December 6-20, 1982, and April 4-22, 1983, Oak Ridge Associated Universities ("ORAU") conducted a radiological survey of Kress Creek. Staff Ex. 1, at 2.

33. ORAU divided the Creek into 50 meter intervals between the River and a point approximately 100 meters south of the storm sewer outfall. ORAU also surveyed the DuPage River at 50 meter intervals for 200 meters upstream and downstream of its juncture with the Creek. Staff Ex. 1, at 4.

34. At each interval, ORAU measured exposure rates at the surface and 1 meter above the surface at 1, 5, 10, and 25 meters from the edge of the Creek or River. Staff Ex. 1, at 5.

35. Systematic boreholes were drilled at locations of direct radiation measurements. Other boreholes not part of the systematic sampling grid were also drilled at selected areas of elevated direct exposure levels. These are called biased boreholes. Radiation profiles in the boreholes were determined by measuring radiation levels at 15-30 centimeter intervals between the surface and the hole bottom. Staff Ex. 1, at 5.

36. Soil samples were collected for laboratory analysis of thorium content from various depths in approximately 15% of the boreholes. Staff Ex. 1, at 5.

37. The data from soil samples was used to construct a correlation between gamma exposure rate and thorium content. Thorium content of all other soils was then estimated using the correlation. Tr. 295; Staff Ex. 1, Tables 5, 6, and 7, and Figure 1, p. D-3.

38. Sediment samples were collected at 100 meter intervals in the stream channels along Kress Creek and the River, except for those areas in which rocky or gravelly bottoms prevented the collection of such samples. Staff Ex. 1, at 6; Tr. 259.

39. Thorium is the predominant radioactive material in the soil. Thorium-232 and Thorium-228 were found to be nearly always in secular equilibrium. Thus, the measured concentrations of thorium (Th-232 and Th-228) are effectively the measurements of total radium (Ra-224 and Ra-228) as well. Staff Ex. 1, at 10-12; Kerr-McGee Volume Testimony, at 2 n.1.

40. Radium-226 and uranium-238 are present in soils and sediments at inconsequential concentrations and are not a health hazard. Staff Ex. 1, at 10, 13.

41. Baseline thorium concentrations in the soil, according to ORAU, averaged 1.6 pCi/g total thorium (Th-228 and Th-232). Staff Ex. 1, at 31 Table 1.

42. Average levels of thorium concentration reported by ORAU in the vertical soil profiles at 1 m from the Creek edge, were 26.1 pCi/gm

at the surface; 40.2 pCi/g at a depth of 15 cm; 38.9 pCI/g at 30 cm; 28.9 pCi/g at 60 cm; and, 18.7 pCI/g between 60 and 90 cm. Staff Ex. 1, at 10. The surface values may be in error by up to 50% because of the geometry of the counting device. Tr. pp. 323-26.

43. Thorium concentrations in the soil generally decrease with distance from the Creek edge. The concentrations decrease by approximately 50% at 5 meters from the edge of the Creek, and at 25 meters decrease to near to background. Staff Ex. 1, at 10; Tr. 234.

44. Maximum thorium concentrations were typically 15-30 centimeters deep along the banks of the Creek and River. Staff Ex. 1, at 11. The more highly contaminated material is generally buried below 15 centimeters of less contaminated material. Tr. 246, 327.

45. There is considerable error in the ORAU soil concentration measurements. The 95% confidence interval around a measurement of 10 pCi/g is approximately 4 pCi/g to 30 pCi/g. Tr. 335. The 95% confidence interval around a measurement of 100 pCi/g is approximately 40 pCi/g to 170 pCi/g. Tr. 336. Any particular measurement thus has a very large error associated with it. Tr. 308.

46. Exposure rates at 1 meter above the surface averaged 28 uR/h at 1 meter from the Creek edge; 25 uR/h at 5 meters from the edge; 21 uR/h at 10 meters from the edge; and 14 uR/h at 25 meters from the edge. Staff Ex. 1, at 7. At 25 meters, average exposure rates are slightly above background. Staff Ex. 1, at 8.

47. There is large statistical variation in the ORAU estimates of thorium in soil. The authors of the ORAU report had not previously

estimated the magnitude of uncertainty by statistical means and board efforts to develop confidence intervals by examination at hearing were inconclusive. Inspection of the ORAU correlation that yielded estimates of thorium in soil leads the Board to conclude that roughly 95% of the data is clustered about the line of correlation in an interval that appears to have a width of about one decade on the vertical logarithmic scale. Tr. 295-312. Staff Ex. 1, figure 1, Page D-3.

48. Exposure rates at 1 meter above the surface along the River downstream of its juncture with the Creek averaged 36 uR/h at 1 meter from the edge; 31 uR/h at 5 meters from the edge; 18 uR/h at 10 meters from the edge; and 20 uR/h at 25 meters from the edge. Staff Ex. 1, at 7.

49. ORAU estimates that background gamma exposure rates in West Chicago are 8.6 uR/h. Staff Ex. 1, at 7. A survey by another NRC contractor, Argonne National Laboratories, found a higher background. Kerr-McGee Ex. 1, at 2. The Argonne survey found that 95% of all readings were between 14 and 25 uR/h. The difference in reported background values could be the result of the fact that the background measurements were taken at different locations. Tr. 253, 255.

50. Thorium levels in the creek sediment samples fluctuated from place to place from less than 0.34 pCi/gram to 131 pCi/gram. Staff Ex. 1, at 12.

51. Thorium concentrations decreased with depth in sediments. Staff Ex. 1, at 12.

52. The sediment data characterize only the parts of the Creek bed with a sandy or silty bottom, which is a subset of the Creek bed. Tr. 260, 268. There is no evidence that thorium collects on rocky bottoms in the Creek. Tr. 315.

53. Approximately 70% of the Creek bottom is composed of gravel and hard substrate, with 30% consisting of softer sediment. Tr. 586.

54. One of 337 systematic ORAU gamma exposure measurements taken at one meter from the surface along the Creek exceeded 100 uR/hour. Tr. 248, 250.

55. One of 68 systematic ORAU gamma exposure measurements taken at one meter from the surface along the DuPage River exceeded 100 uR/hour. Tr. 250, 251.

56. The contamination along the Creek and River is spotty and not constant or evenly distributed. Tr. 278, 279. Several additional widely scattered locations in excess of 100uR/hr at the surface exist further from the Creek banks; however, a substantial majority of all readings show exposure rates well below the 100 uR/hr level. Staff Ex. 1, Table 2.

57. The biased sampling which was a deliberate search for areas having high levels of exposure showed that there are many specific sites having direct exposure rates above 100 uR/hr and ranging upward beyond 800 uR/hr either at the surface or one meter above it. Staff Ex. 1, Table 4.

58. There is no evidence that the thorium is now migrating or moving. Tr. 247.

59. During the fall of 1985, Kerr-McGee undertook a systematic survey of gamma exposure rates for all properties in the Creek vicinity for which permission to survey could be obtained. The survey covered some 80% of the properties along the Creek. Kerr-McGee Risks Testimony, App. B., at B-1 & n.1.

60. The properties were surveyed along a rectangular grid with a spacing of five feet, except that a ten-foot grid was used in certain non-residential downstream areas. Kerr-McGee Risks Testimony, App. B., at B-1 & n.2.

61. The total area surveyed was about 3,200,000 ft^2. The total area with gamma readings in excess of 50 uR/h was about 67,900 ft^2, or 2.1% of the total area surveyed. Risks Testimony, App. B, at B-2, n.2

62. Of the area with a concentration in excess of 50 uR/h, 91.3% (or 1.9% of the total area surveyed) was contaminated at levels between 50 and 99 uR/h. Only 6.3% of the area contaminated to over 50 uR/h (or 0.13% of the total area surveyed) showed readings of 100 to 149 uR/h. Only 2.4% of the area contaminated to over 50 uR/h (or 0.05% of the total area surveyed) showed readings of over 150 uR/h. Kerr-McGee Risks Testimony, App. B, at B-2 & Table B-1; Letter from R. A. Meserve to John H Frye, III, Esq. (May 6, 1986).

63. Locations contaminated above 150 uR/h had an average area of 450 ft^2. The maximum area of such a location was 600 ft^2. Kerr-McGee Risks Testimony, App. B, at B-2.

64. Kerr-McGee's survey showed that contamination is spotty. The "hot spots" are small and discrete regions. Kerr-McGee Risks Testimony,

App. B, at B-2; Letter from R. A. Meserve to John H Frye, III, Esq. (May 6, 1986) (enclosing maps). The Kerr-McGee survey results are in reasonable agreement with those obtained by ORAU, which also show that elevated levels of radioactivity occur in relatively small and discrete "hot spots" with remaining areas contaminated at detectable but low levels. Staff Ex. 1; Tables 2, 3 and 4.

The Risk Posed by the Contamination

65. The levels of radium-226 in Kress Creek are inconsequential. Staff Ex. 1, at 10, 13. Kress Creek involves radium-228. Kerr-McGee Risks Testimony, at ii; Cool/Shum Testimony, at 3.

66. The EPA's risk analysis for its radium-in-soil standards focuses on the risk from constructing a house on soil contaminated with radium-226. Tr. 443; 1 FEIS, at 9-14 to 9-16.

67. The risk of constructing a home in soil containing radium-228 is appreciably less than the risk from constructing a home in soil containing radium-226. Tr. 445.

68. A typical home in Chicago has a ventilation rate of one air change per hour. Tr. 648. A detailed calculation reveals that, if a typically ventilated home were built on soil containing equal concentrations of radium-228 and radium-226, the concentration of radon daughters would be approximately 30 times greater than the concentration of thoron daughters. Kerr-McGee Risks Testimony, at Table III-1; Tr. 649.

69. Thoron decay products have about one-third the health risk of radon decay products from inhalation. Tr. 445, 649.

70. The overall risk resulting from building a home on soil containing radium-228 is thus a factor of 90 less than the risk of building on soil containing the same activity of radium-226. Kerr-McGee Risks Testimony, at 27-28; Tr. 649.

71. Appendix G of the FEIS includes an analysis of the risks to a regional population from a model tailings pile. 1 FEIS, App. G.

72. The evaluation in the appendix is an exact counterpart to the analyses in the body of the FEIS to justify the flux standard that was adopted by EPA to govern the stabilization of a tailings pile. Compare 1 FEIS chaps. 5-6 with id. App. G.

73. EPA's flux standard has an entirely different risk basis than its radium-in-soil standard. Compare 1 FEIS chaps. 5-6 with id. at 9-14 to 9-16.

74. The situation along Kress Creek is unlike EPA's model tailings pile. The average surface concentration is approximately 20 pCi/g of total thorium, or 10 pCi/g of radium-224, rather than the 280 pCi/g of radium-224 assumed for a model pile. Tr. 474. The yearly emissions of thoron from the Creek area are approximately 1.8×10^3 C/year, or approximately 1/200 of the emissions from the model tailings pile of 3.4×10^5 C/year. Tr. 477. Thus, the risk to a regional population from Kress Creek is about 1/200 the risk from the hypothetical tailings pile. Tr. 478.

75. With the exception of radon-220 (thoron), all decay products of thorium-232 are solids and thus will remain as constituents of the soil. Kerr-McGee Risks Testimony, at 5.

76. Thoron has a half-life of 55 seconds. Kerr-McGee Risks Testimony, at Figure I-1.

77. There are three major pathways by which human exposure from materials along the Creek might occur. First, those present in the immediate vicinity of the materials might be exposed to gamma radiation. Second, vegetables grown in the soil could take up thorium and its decay products, leading to exposure from consumption of home-grown produce. Third, humans could inhale thoron and its daughters. Kerr-McGee Risks Testimony, at 6.

78. Although other potential pathways exist, such as dust inhalation or direct ingestion of soil, they are insignificant. Kerr-McGee Risks Testimony, at 6.

79. The most probable activities in the Creek area include jogging and hiking, yard work, and backyard play. Kerr-McGee Risks Testimony, at 7.

80. Frigerio estimated maximum occupancy for lawns and gardens experiencing some residential occupancy at 200 hours per year (Kerr-McGee Ex. 1), but 400 hours per year is not unreasonable (Tr. 658). Based on an occupancy time of six hours per day on all fair weather days (assumed to be 50%) for six months of the year we find 540 hours per year is conservative for spatially distributed exposures such as those present here. Tr. 651-63.

81. The highest spatially averaged radiation levels appear to be found at a location 200 meters downstream on the east bank of the creek. Staff Ex. 1, Table 2. The data given do not permit a reliable spatial average to be calculated but suggest that this average would not be greater than 70 uR/hour. This results in a dose of 0.038 rem per year based on a conservation occupancy time of 540 hours.

82. The highest exposure rate measured at a single location by ORAU at one meter above the ground is 210 uR/hour. Staff Ex. 1, Table 4. This results in a dose of 0.042 rems per year based on an occupancy factor of 200 hours per year. We accept 200 hours per year occupancy time as reasonable for estimates related to small areas of high concentration.

83. A criterion of 0.1 rem per year above background would correspond to an 11 microrem per hour rate, if continuous, year-long exposure occurred. Indoor exposure with 75 percent occupancy would meet the criterion if 15 microrem per hour were the limit, since 75 percent of 15 equals 11. If the background exposure is taken as 9 microrem per hour, indoor exposure rates should be limited to 24 microrem per hour.

Conclusions of Law

1. Jurisdiction exists under the Atomic Energy Act independently of the Uranium Mill Tailings and Radiation Control Act to require that a

remedial action plan be prepared which is necessary or desirable to protect health because of the radiological contamination of Kress Creek and the West Branch of the DuPage River.

2. The radium-in-soil standard promulgated by the U.S. Environmental Protection Agency under the Uranium Mill Tailings and Radiation Control Act is not appropriate to protect health in the situation posed by this radiological contamination.

3. Part 20 of the Commission's regulations contains numerical radiological dose limitations which are appropriate to protect health in the situation posed by this radiological contamination.

4. The record in this proceeding does not demonstrate that the Part 20 numerical radiological dose limitations are exceeded as a result of this contamination.

In consideration of the foregoing, it is this 19th day of June, 1986, ORDERED

1. The Order to Show Cause issued to Kerr-McGee Chemical Corporation on March 2, 1984, is hereby dismissed; and

2. This Initial Decision shall constitute the final action of the Nuclear Regulatory Commission thirty (30) days after today unless an

appeal is taken to the Atomic Safety and Licensing Appeal Board pursuant to 10 C.F.R. § 2.762.

THE ATOMIC SAFETY AND
LICENSING BOARD

Dr. Jerry R. Kline
ADMINISTRATIVE JUDGE

Dr. James H. Carpenter
ADMINISTRATIVE JUDGE

John H Frye, III, Chairman
ADMINISTRATIVE JUDGE

Bethesda, Maryland
June 19, 1986