10382

DOCKETED
USNRC

21

'90 MAY 22 P3:30

OFFICE OF SECRETARY
DOCKETING & SERVICE
BRANCH

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of	
KERR-McGEE CHEMICAL CORPORATION	Docket No. 40-2061 ML
(West Chicago Rare Earths Facility)	Judges Moore, Kohl and Wilber

AMICUS CURIAE BRIEF OF THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Pursuant to the March 21, 1990, Memorandum and Order of the Atomic Safety and Licensing Appeal Board ("Appeal Board"), the Appeal Board's further Order of April 24, 1990, and 10 C.F.R. § 2.175(d), the United States Environmental Protection Agency, ("EPA" or "the Agency") files this amicus curiae brief regarding the Atomic Safety and Licensing Board's ("ASLB's") February 13, 1990, Initial Decision authorizing the permanent disposal of radioactive thorium mill tailings and other contaminated materials at the Kerr-McGee Chemical Corporation's ("Kerr-McGee's") West Chicago Rare Earths Facility ("Facility"). By participating in these proceedings, EPA does not waive or otherwise limit the jurisdiction it may have under any statute or other authority, including, but not limited to, the National Environmental Policy Act, 42 U.S.C. §§ 4321 to 4370a, the Clean Air Act, 42 U.S.C. §§ 7401 to 7642, the Safe Drinking Water Act, 42 U.S.C. §§ 300f to 300j-11, the Federal Water Pollution Control

DS03

Act, 33 U.S.C. §§ 1251 to 1387, the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9601 to 9675, and the Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901 to 6991i, to take any action concerning Kerr-McGee, the Facility, or these proceedings.

I. INTRODUCTION

EPA's interest in the present proceedings arises from the Appeal Board's invitation to file a brief as an *amicus curiae*. The Agency also has responsibilities under the National Environmental Policy Act and the Clean Air Act to review and comment publicly on the environmental impacts of federal activities. Consequently, the Agency has provided comments to the Nuclear Regulatory Commission ("NRC") on the Draft Environmental Statement, the Final Environmental Statement, the draft Supplement to the Final Environmental Statement and the final Supplement to the Final Environmental Statement ("SFES") relating to the licensed activities at the Facility. Our July 27, 1989, comments o the SFES [Attachment 1] best summarize our concerns with these documents and with those portions of the ASLB's Initial Decision which rely on them. This brief discusses only certain technical information obtained by the EPA since the ASLB's Initial Decision and issues raised by the Initial Decision itself. As set forth below, the EPA believes that the disposal method currently approved in the Initial Decision may not meet all of the applicable standards found in 40 C.F.R. Part 192. EPA recommends that the Appeal Board remand this matter to the ASLB to address adequately the concerns raised by the Agency in its July 27, 1989 comments and this _amicus curiae_ brief.

II. DISCUSSION

A. Background

In 1978, Congress enacted the Uranium Mill Tailings Radiation Control Act, 42 U.S.C. §§ 7901 _et_. _seq_., ("UMTRCA"), to provide a program to regulate the processing and disposal of uranium and thorium mill tailings, finding that:

> the protection of the public health, safety, and welfare ... require(s) that every reasonable effort be made to provide for the stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings.

42 U.S.C. § 7901(a).

UMTRCA requires EPA to promulgate standards of general application for the protection of health, safety and the environment from radiological and non-radiological hazards associated with residual radioactive materials. 42 U.S.C. § 2022. EPA promulgated such standards for licensees of the NRC (the "Mill Tailings Standard"), now codified at 40 C.F.R. Part 192, on October 7, 1983. 48 Fed. Reg. 602 (1983). These standards afford protection of human health from the effects of radioactive and toxic constituents of thorium mill tailings. Among other things, the standard also protects health and the environment by requiring protection of groundwater from leaching of radioactive and toxic constituents from thorium mill tailings.

Section 2022(b) of UMTRCA further provides that requirements established by the NRC with respect to byproduct material shall conform to the Mill Tailings Standard. Accordingly, the NRC promulgated criteria (the "NRC Implementing Rules"), which appear as Appendix A to 10 C.F.R. Part 40, to bring regulations it had adopted in 1980 to implement its own obligations under UMTRCA into conformity with the Mill Tailings Standard. 50 Fed. Reg. 41,852 (1985). Thus, under the UMTRCA scheme, the Mill Tailings Standard and the NRC Implementing Rules operate together to regulate the final disposal project proposed for the Facility.

Among the changes implemented by the NRC to conform to the Mill Tailings Standard is Criterion 1, which lists characteristics of tailings sites to be considered in siting and design decisions. According to this Criterion, in order to achieve the general goal of permanent isolation of tailings and associated contaminants, the NRC must optimize characteristics such as remoteness from populated areas, continued isolation from groundwater sources and potential for minimizing erosion "to the maximum extent reasonably feasible" in the site selection process. In addition, Criterion 6 states that the earthen cover placed over tailings at the end of milling operations must provide reasonable assurance of controlling radiological hazards for 1,000 years, to the extent reasonably achievable. Criterion 12 provides that the final disposition of mill tailings should be such that ongoing active maintenance is not necessary to preserve isolation.

B. The EPA-Commissioned Studies

As noted above, EPA submitted comments to the NRC on the various environmental impact statements on which the ASLB relied in issuing its Initial Decision, see, e.g., Initial Decision at 79-81. To further assess its concerns as to whether the disposal method approved in the ASLB's Initial Decision meets the requirements of the Mill Tailings Standard, EPA commissioned two studies: the Technical Information Memorandum: Review of Kerr-McGee West Chicago Rare Earths Facility Disposal Plan Design, prepared by Rogers and Associates Engineering Corporation, April 13, 1990, ("Rogers Memorandum") [Attachment 2]; and, the Final Report, Kerr McGee Chemical Corporation Rare Earths Facility, Evaluation of Resistance to Erosion, prepared by NUS Corporation, May 4, 1990, ("NUS Report") [Attachment 3]. Although the EPA informed the ASLB prior to its Initial Decision that such reports were forthcoming, the reports were not finalized until after that decision. As explained below, both reports indicate that the disposal method discussed in the SFES and approved in the ASLB's Initial Decision is not consistent with certain of EPA's health and environmental requirements contained in the Mill Tailings Standard.

1. Control of Radiological Hazards for 1,000 Years. The Mill Tailing Standard requires that disposal cells for thorium byproduct material be designed to provide reasonable assurance of control of radiological hazards "for one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years." 40 C.F.R. §§ 192.32(b)(1)(i) and 192.41. The NRC has adopted this requirement in Criterion 6 of the NRC Implementing Rules. The record before the ASLB indicates that Kerr-McGee does not attempt to demonstrate that meeting the primary requirement (1,000 years) is not reasonably achievable. The ASLB simply adopts the 200 year minimum assurance requirement without explanation. See Memorandum and Order Ruling on Illinois' Request for Reconsideration, February 13, 1990, Docket No. 83-495-01-ML, at 8. Using reasonable design features, the Department of Energy has achieved the 1,000 year primary requirement at all the sites subject to the Mill Tailings Standard that are under its jurisdiction, including the Canonsburg, Pennsylvania, tailings disposal site located in a meteorological environment similar to that of West Chicago and relied upon by Kerr-McGee to illustrate the adequacy of its own proposed cell design. The failure of the record for the Initial Decision to discuss the achievability of control from radiological hazards for 1,000 years, in conformity with the Mill Tailings Standard and Criterion 6, constitutes a significant flaw in the reasoning which underlies the Initial Decision.

2. Selection of Design Storm. In developing the Mill Tailings Standard, EPA prepared several technical background documents and an environmental impact statement to analyze the likely effect that implementation of the standard would have on human health and the environment. The Final Environmental Impact Statement for Standards for the Control of Byproduct Material from Uranium Ore Processing, 40 CFR 192, EPA 520/1-83-008-1, Volume I, p 8-8, [Attachment 4] provides that, as it pertains to erosion resistance relevant to Kerr-McGee's proposed disposal cell, "reasonable assurance" of control of radiological hazards means use of the Probable Maximum Precipitation (PMP) event in disposal cell design, since no other reference precipitation event (100 year, 200 year storm, etc.) carries reasonable assurance (e.g., 95% probability) that a more severe event will not occur within 1,000 years. Hence, to be adequately protective of human health and the environment, a disposal cell design should be modelled to withstand the PMP event.

In this case, in calculating the long-term effectiveness of its proposed disposal cell, Kerr-McGee relied exclusively upon a Bureau of Reclamation document which provides for modifications to the PMP for the design of small dams to use design storm precipitation estimates lower than the PMP. See February 13, 1990, Memorandum and Order Ruling on Illinois' Request for Reconsideration, Docket No. 40-2061-ML, at 5, 8. The Bureau of Reclamation allows graded modifications to the PMP when property damage is the relevant consideration in the event of dam failure, but allows no such modification when there is a potential for loss of life. As the principle purpose of the Mill Tailings Standard is to protect human health and the environment, not to limit property damage, modifications to the PMP based upon criteria designed to protect against property loss do not appear to be appropriate to demonstrate compliance with the standard. Moreover, Kerr-McGee has not attempted to demonstrate that design of the disposal cell to withstand the unmodified PMP is impracticable,[1] or that the objectives of the standard can be met by the proposed lesser design basis.

Section 2.1 of the Rogers Memorandum [Attachment 2] and Sections 3.0 through 10.0 of the NUS Report [Attachment 3] demonstrate that Kerr-McGee used an inappropriate precipitation event, which significantly detracts from the reasonable assurance that the proposed disposal cell will control radiological hazards for 1,000 years. Since the Facility occupies less than one square mile of land, Kerr-McGee should have employed a 1 hour, 1 square mile event, with appropriate consideration of shorter time periods (NUS Report at 3); instead, Kerr-McGee utilized a 6 hour, 10 square mile storm. The design basis of a reasonably anticipated maximum precipitation event of 17.6 inches per hour, which is appropriate to the 1,000 year design, has been reduced in the record to a 1.5 inches per hour event. In other words, the ASLB accepted use of Kerr-McGee's design basis storm for the

---

[1] The Department of Energy's experience suggests that this requirement is readily achievable. <u>See</u> <u>supra</u> at 6.

proposed cell that is less than ten percent of the appropriate event. In fact, the modified precipitation event used to calculate the cell's protectiveness (1.5 inches per hour) is significantly less than the precipitation estimate for even a 200 year event (Rogers Memorandum, Section 2.1.3 and Table 1).

On remand, Kerr-McGee should be required to employ the proper PMP event in order to demonstrate that the proposed disposal cell design reasonably assures control of radiological hazards for 1,000 years unless that is shown to be not reasonably achievable.

3. Reliance Upon Long-term Maintenance. The legislative history of the UMTRCA provides that "uranium mill tailings should be treated ... in accordance with the substantial hazard they will present until long after existing institutions can be expected to last in their present forms." H.Rep. No. 1480, 95th Cong., 2d Sess. 17 (1978). EPA rejected reliance on institutional controls (e.g. active maintenance) to control radiological hazards in its rulemaking for the Mill Tailings Standard under UMTRCA. 48 Fed. Reg. 45,936 (1983). Similarly, Criterion 1 of the NRC Implementing Rules, which was promulgated by the NRC to conform with the Mill Tailings Standard, establishes as the general goal in siting decisions regarding the disposal of mill tailings the permanent isolation of the tailings without ongoing maintenance: "Tailings should be disposed of in a manner that no active maintenance is required to preserve conditions of the

site." Criterion 12 of the NRC Implementing Rules reiterates this objective.

The ASLB has made no finding, and Kerr-McGee has made no demonstration, that the vegetative cover can survive without active maintenance for 1,000 or even 200 years. Therefore, the current record does not show that reliance on self-sustaining vegetative cover for the primary barrier to erosion adequately assures that the cell design will reasonably control the radiological hazards at the Facility.

The West Chicago Project Engineering Report (the "Engineering Report") (April 1986) developed by Kerr-McGee in support of the SFES, which, in turn, supports the ASLB's Initial Decision (See Initial Decision at 2, 77-87), indicates that the erosion analysis of the proposed disposal cell places sole reliance on the continuous presence of a vegetative cover as erosion protection. The Engineering Report contains no detailed specifications of other, passive protective barriers (e.g., the clay/cobble layer) and erosion analyses thereof, under any design storm scenario. While it is commonly accepted in the engineering community that vegetative cover in good condition offers resistance to erosion, there is no basis in the present record for a reliance on vegetative cover as a primary barrier without active maintenance to mitigate the effects of fire, drought, disease or intrusion on such cover.

Section 2.1.3 of the Rogers Memorandum indicates that in the absence of vegetative cover on parts of the cell, in a PMP event the bare spots would be subjected to erosive forces that exceed the recommended design parameters. Specifically, the erosion water velocity on exposed clay (5.0 feet per second) for a one hour PMF event would exceed the recommended 3.5 feet per second.[2] Section 5.0 of the NUS Report demonstrates that erosive forces approaching the permitted maximums may occur on sideslopes in spite of uniform cover with prairie grass, and that without such vegetative cover, precipitation flow velocities on both the cap (4.9 feet per second) and side slopes (7.6 feet per second) exceed the recommended maximum permissible velocity (2.5 feet per second), the design standard necessary to provide an accepted margin of safety against erosion.

In order to provide reasonable assurance that the disposal cell will control radiological hazards for 1000 years without the need for active maintenance, the Appeal Board should remand this matter to the ASLB for further examination of Kerr-McGee's reliance on vegetative cover as a primary erosion barrier. It may be adequate on remand for Kerr-McGee to provide comprehensive specifications of a primary barrier (clay/cobble layer), including rock quality and size distribution, and an

---

[2] As the Rogers Memorandum indicates at Section 2.6, the appropriate design assumption for a weathered surface is silty clay.

analytical demonstration that such a barrier will withstand the erosive forces of the unmodified PMP event.[3]

4. Additional Findings of Contractor Reports. In addition to the aforementioned items, the Appeal Board's attention is invited to the recommendation made on pp. 20-21 of the NUS Report. In the opinion of the consultant, the spillway of the detention/sedimentation pond associated with Kerr-McGee's disposal cell does not have sufficient capacity (i.e., freeboard) to pass the runoff associated with a PMP event. Since the cell design must be able to withstand the PMP event, additional freeboard should also be provided for the detention/sedimentation pond.

Also, Section 2.0 of the Rogers Memorandum indicates that the annual organ radiation doses appearing in Table 5.11 of the SFES will not meet the specific organ dose requirements of the Mill Tailings Standard[4], because they do not include dose contributions for the year of estimation due to biologically

---

[3] It may be adequate on remand for Kerr-McGee to provide comprehensive specifications of a primary barrier (clay/cobble layer), including rock quality and size distribution, and an analytical demonstartion that such a barrier will withstand the erosive forces of the unmodified PMP event. Rogers Memorandum at 4-2. While the technical details remain within the purview of the NRC, the agency charged with implementing EPA's standards, based upon the two attached technical evaluations, the present design specifications do not meet EPA's expectations for reasonable assurance that its standards have been met.

[4] This requirement is "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 the planned discharge of radioactive materials." 40 C.F.R. § 192.41(d).

retained radionuclides. This issue is further clarified in the attached affidavit of James C. Benetti, U.S EPA Region V, February 22, 1990, [Attachment 5], filed with the Appeal Board in support of the State of Illinois' Motion for Stay.

EPA believes that, in accordance with Agency policy, the ASLB should have required Kerr-McGee to demonstrate compliance with the dose standard at 40 C.F.R. § 192.41(d) by calculating the organ dose equivalents for each year of the action phase (as described in the SFES) which is attributable to intakes of radionuclides from the Facility up to and including the year in question. Kerr-McGee should then demonstrate that the largest annual dose computed in this manner does not exceed the standard. If compliance with the dose standard cannot be demonstrated in this manner, then additional control measures may be necessary. See. Attachment 5, Paragraphs 5, 7.[5]

C. Other Concerns

The EPA has also identified two legal procedural issues concerning the ASLB's application of the NRC Implementing Rules to the evaluation of the disposal alternatives in its Initial

---

[5] Section 3.0 and Appendix B of the Rogers Memorandum indicate that the proposed design would not comply with the requirements of the Clean Air Act, should the National Emission Standard for Hazardous Air Pollutants - Radionuclides come into effect for NRC licensees prior to construction of the disposal cell. This standard, to be codified at 40 C.F.R. Part 61, Subpart I, is currently stayed and is under reconsideration. 55 Fed. Reg. 10,455 (1990).

Decision. Since the City of West Chicago and the State of Illinois have already briefed the Appeals Board on these issues extensively, the Agency shall summarize its concerns in short form.

1. Consideration of Design Failure. The record before the ASLB raises serious questions as to whether the alternatives in the SFES were adequately evaluated. Given the potential impact to human health and the environment in the event of design failure, any inadequacy apparently would contravene the NRC Implementing Rules' emphasis on siting rather than engineering as a means of reasonably assuring isolation of radiological hazards. 45 Fed. Reg. 65,221 (1980). The oversight in failing to consider what would happen in the event of failure of the chosen remedy is particularly troubling where, as here, the site for the proposed disposal cell overlies a major aquifer. See also City of West Chicago's Memorandum in Support of its Appeal of the ASLB's Decision Granting License Amendment at pages 20 through 25.

2. Consideration of Alternate Sites. Criterion 1 provides that isolation of tailings should be given primary emphasis over short-term conveniences such as minimization of transportation costs. Accordingly, the record before the Appeal Board raises serious questions as to whether the ASLB contravened NRC's own rules by the manner in which it considered monetary savings to Kerr-McGee regarding transportation costs in evaluating site

alternatives. See also City of West Chicago's Memorandum at pages 11 through 19 and Brief of the People of the State of Illinois at pages 14 through 18.

III. CONCLUSION

In conclusion, for the foregoing reasons EPA recommends that the Appeal Board remand this matter to the ASLB to address adequately the concerns raised by the Agency in its July 27, 1989, comments and in this *amicus curiae* brief.

Respectfully submitted,

U.S. ENVIRONMENTAL PROTECTION AGENCY

By: Bertram C. Frey
Bertram C. Frey
Acting Regional Counsel

Dated: May 21, 1990

Bertram C. Frey
Marc M. Radell
Office of Regional Counsel
U.S. EPA, Region V
230 S. Dearborn St.
Chicago, Illinois 60604
(312) 886-7948

AMICUS CURIAE BRIEF OF U.S. EPA

INDEX TO ATTACHMENTS

Number	Document
I.	Letter from Robert Springer, Assistant Regional Administrator for Planning and Management, to Jerry Swift, Nuclear Regulatory Commission, July 27, 1989
II.	Technical Information Memorandum: Review of Kerr-McGee West Chicago Rare Earths Facility Disposal Plan Design, prepared by Rogers and Associates Engineering Corporation, April 13, 1990
III.	Final Report Kerr-McGee Chemical Corporation Rare Earths Facility Evaluation of Resistance to Erosion, prepared by NUS Corporation, May 4, 1990
IV.	Final Environmental Impact Statement for Standards for the Control of Byproduct Materials from Uranium Ore Processing (40 CFR 192), Volume 1, September, 1983 (selected pages)
V.	Affidavit of James Benetti, February 22, 1990

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

REPLY TO THE ATTENTION OF:

27 JUL 1989

Jerry Swift
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Swift:

In accordance with our responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act, we have reviewed the Supplement to the Final Environmental Statement (SFES) for the Decommissioning of the Rare Earths Facility, West Chicago, DuPage County, Illinois. The proposed project would provide permanent disposal of the Kerr-McGee Rare Earths Facility wastes located at West Chicago, Illinois. The waste materials consist of sands, sludges and sediments produced during the processing of thorium and rare earth compounds. The SFES examines several alternative disposal sites including on-site disposal at the West Chicago site (the preferred alternative) and four other sites located in Fulton, Peoria, Douglas and Livingston Counties, Illinois.

We previously provided comments on the Draft Supplement to the Final Environmental Statement (Draft SFES) on October 2, 1987. At that time, we indicated that we had significant reservations regarding the proposed project. We were concerned about the project's potential adverse impacts on public health. We were also concerned that the Draft SFES did not provide a fair analysis of feasible alternatives to the proposed project.

Many of our Agency's reservations about this project have still not been adequately addressed in the SFES. Our Agency met with you and several representatives of your Agency and Argonne National Laboratory on June 30, 1989. During that meeting, we stated our major concerns and indicated that we needed additional information before our Agency could make any determination about this project. This letter provides a summary of our concerns and the additional information needed. Enclosed is a detailed discussion of our concerns and a listing of the additional information required from your Agency in order for us to make a determination regarding this project.

Our major concerns about this project fall into nine basic categories. These nine categories are listed below:

Radiation Effects
Groundwater Impacts
Surface Water Impacts
Compliance with EPA Regulations for Long Term Maintenance
Compliance with NRC Siting Criteria Regulations
Off-Site Transportation Costs and Health Effects
Consideration of In-Situ Vitrification Processes
Off-Site Waste Areas
Resource Conservation and Recovery Act (RCRA) Issues

The enclosed comments provide a detailed list of information needed by category. Once we receive the information requested, our Agency can prepare our final comments on the proposed project. Until this information is provided, we cannot assign a rating to the SFES.

We appreciated the opportunity to meet with you on June 30. We look forward to continuing to work with your Agency to formulate an acceptable solution to the permanent disposal of wastes from the Kerr-McGee Rare Earths Facility. If you have any questions about these comments or need further information, please contact Jerri Horst of the Environmental Review Branch at FTS 886-4244.

Sincerely yours,

Robert Springer

Robert Springer
Assistant Regional Administrator
for Planning and Management

Enclosure

U.S. Environmental Protection Agency
Region V Preliminary Comments
and Request for Additional Information Regarding the
Supplement to the Final Environmental Statement (SFES)
Related to the Decommissioning of the Rare Earths Facility
West Chicago, Illinois

Project Description

The proposed project would provide permanent disposal of the Kerr-McGee Rare Earths Facility wastes located at West Chicago, DuPage County, Illinois. The waste materials consist of sands, sludges and sediments produced during the processing of thorium and rare earth compounds. The SFES examines several alternative disposal sites including on-site disposal at the West Chicago site (the preferred alternative) and four other sites located in Fulton, Peoria, Douglas and Livingston Counties, Illinois. The discussion below states our major concerns regarding the project and stipulates the additional information needed from the Nuclear Regulatory Commission (NRC) before our Agency can make any determination regarding the environmental and public health impacts of the proposal.

Radiation Effects

In our previous letter on the Draft SFES dated October 2, 1987, we indicated our concern that the radiation doses to the most exposed individuals exceeded the 25 millirem (mrem) per year organ dose limit of 40 CFR Part 192. Specifically, Table 5.11 of the Draft SFES estimated doses of 590 mrem to bone and 290 mrem to lung over a seven year action period, or 84 and 41 mrem per year, respectively. Recalculated doses appear as 13 mrem to bone and 15 mrem to lung over the same period. This recalculation is not substantiated by supporting documentation showing the basis and steps of the revised estimate. In our meeting with staff of the Nuclear Regulatory Commission (NRC) and Argonne National Laboratory on June 30, 1989, we learned that recalculated values of dose to the public are expressed as annual doses attributable to the action period only, rather than 50 year committed doses. This is an unacceptable method for the purpose of the SFES and would not be allowed in any case, for the "Application for Approval to Construct" which will be required under 40 CFR Part 61.

For purposes of evaluation of the proposed alternative against the radiation protection standards of 40 CFR Parts 190 and 192, annual organ doses are to be calculated as the sum of the dose received from emissions occurring in the year in question, plus the contributions from all radionuclides retained in the body from previous years' exposure to emissions resulting from facility operations up to 50 years previous (essentially the operating history of this facility). Since this calculation will be difficult to perform and to document, 50 year committed dose to each affected organ will be acceptable. If 50 year committed dose is not provided, the entire computation, with supporting documentation for each years' exposure is required. For purposes of demonstration of compliance with 40 CFR Part 61, the effective dose equivalent (50 year committed dose) is required.

In order to correct this problem, the following information is required:

- A description of all assumptions used in the calculations and justification for their use.
- A description and substantiation of all meteorological data used.
- The revised schedule of operations and waste inventories cited in Response 11-1 of Volume 2 of the SFES.
- Documentation supporting the version and justification of the computer model used to perform the calculations. Use of the COMPLY code is recommended, since this code is required for NESHAPS applications.
- Computation of 50 year committed doses to all organs, (or else detailed calculations and documentation as described above which include the contributions from all past years of exposure in the estimated annual organ doses), and computation of effective dose equivalent (due only to internal exposure) for each year of the action period, and for the long term.
- Submission of the actual detailed computer output, showing all input parameters, with doses (both effective dose equivalent and dose to the critical organ(s)) displayed in 16 directions to receptors beginning with the closest individual, and extending to 1,000 meters beyond the closest individual.
- A description of all measures planned to be taken so as to maintain exposures to the public during the action period as low as reasonably achievable (ALARA).

The above information is required so that we can evaluate whether the preferred alternative will comply with applicable radiation protection provisions of 40 CFR Parts 61, 190, and 192. Based upon the estimates made in the Draft SFES, it appears that the project would fail to meet important provisions of Parts 190 and 192, and that it may also fail to meet the requirements of the proposed Part 61.

At our June 30 meeting, we stated that our Agency has taken measurements of the direct gamma exposures from the waste pile to nearby residents. Some measurements have shown exceedances of the 25 mrem per year provision of 40 CFR Part 190. NRC indicated that their Agency's measurements do not show exceedances of this standard. NRC and Argonne staff have requested copies of our Agency's data showing this violation; we are sending this data under separate cover. The fact that nearby residents are being exposed to "shine" from the pile has been known for some time. For example, in 1977, EG&G, under a Department of Energy (DOE) contract, performed a flyover gamma radiation survey of the West Chicago site. This survey clearly showed the presence of shine from the pile. Recently, our Agency and the State of Illinois have performed independent surveys which clearly show that a number of residents living at and near the edge of the site are being exposed in excess of 40 mrem per year from shine. EG&G has recently conducted a second flyover survey which corroborates the presence of shine.

The direct gamma radiation exposure to the public is not addressed in the SFES. This issue must be addressed. We have major concerns that current NRC data do not show the presence of offsite gamma above background levels.

Therefore, the following information must be provided:

- all current documentation of fenceline and offsite gamma radiation levels in the possession of NRC.
- An explanation of the basis for the discrepancy with EPA, Illinois and DOE measured values.
- Inclusion of direct gamma exposures in the estimates of Total Effective Dose Equivalent appearing in Table 5.11 of the SFES.
- Description of interim measures to be taken to reduce gamma exposures to levels such that the site achieves compliance with the radiation protection standards of 40 CFR Parts 190 and 192 both prior to and during the action period.

The preferred alternative is to be designed to comply with the radon emission standard of 20 picocuries per meter squared per second of 40 CFR Part 192. However, as discussed with NRC staff at our June 30 meeting, the proximity of the site to the exposed public will not afford ample protection from radon. Modeling of the source by EPA using AIRDOS-EPA results in maximum individual risk levels of 4 in ten thousand, which is generally not acceptable as a design goal by our Agency. Due to the difficulty in adequately modeling emissions of radon from an area source in such close proximity to the public, it is appropriate that a design goal of 1 in a million be demonstrated. This design goal is necessary in this specific situation to insure an ample safety margin since there is little safety margin inherent in the proposed alternative. Therefore, the NRC must also provide the following information:

- Use of a suitably documented computer model to demonstrate that a design goal risk level of 1 in a million can be achieved.
- A copy of the computer output, showing all input and assumptions used to verify that the proposed alternative, modified if necessary, will attain the design goal.

The SFES does not formally present a plan, based upon applicable standards, to clean up that part of the current site which will be released for unrestricted use. This clean up plan should include provisions both for affected soils and groundwater. Therefore, the following information must also be provided:

- A plan to clean up soils to the criteria specified in 40 CFR Part 192.
- A plan to assess the extent of groundwater contamination under the current waste pile when it is moved and to take appropriate remedial actions to clean up any groundwater contamination to appropriate levels.

Groundwater Impacts

The analysis of long term groundwater impacts was conducted in a manner which favors a site which does not limit contaminant migration. Some of the alternate sites are situated in low-permeability geologic materials such as glacial tills (e.g., Alternative D). Much of the West Chicago site, however, is immediately underlain by layers of sand. Because of the higher permeability of the materials underlying the West Chicago site, NRC found that dilution and dispersion would reduce the concentration of contaminants in the groundwater as measured at the boundary of the waste in the downgradient direction. At alternate sites underlain by low-permeability materials, however, the SFES indicated that the contaminant concentrations just outside of the disposal cell will be considerably higher than those projected for the West Chicago site. This is an unacceptable method of comparison. A site which does not naturally limit contaminant migration will always win in this scenario over the type of site which is actually favored for waste disposal, i.e., a site which contains low-permeability soil materials. A proper comparison would assess the potential long-term impacts on the nearest aquifer. Clearly, the low-permeability materials which are assumed to underlie the farm site (Alternative D) would not constitute an aquifer. The materials which underlie the West Chicago site, however, are quite permeable and could potentially be utilized as a source of drinking water, and therefore, are an aquifer.

Our Agency needs the following information to better analyze the impacts to the groundwater aquifers as a consequence of the proposed action:

- More detailed groundwater flow maps (preferably at a larger, consistent scale) of the glacial and bedrock aquifers beneath the sites.
- Maps delineating the shape, extent, and concentration of contaminant plumes within the aquifers.
- Summary table(s) of drinking and monitoring wells and groundwater data, including well type, location, construction depth, screened interval, depth to groundwater, top-of-casing elevation, water level elevations and dates measured.
- Detailed, larger scale maps showing locations, types and identification numbers of all water supply and monitoring wells within one mile of the site(s). The map shown on page 4-92 of the SFES does not provide this information at a sufficient level of detail.
- A clearer, more detailed explanation of the physical, chemical, and radiological behavior of the groundwater contaminant plume(s) both prior to and after isolation of the wastes. Given the number of pumping wells in the general vicinity of the sites, plume movement and behavior must be thoroughly assessed, explained and depicted.
- Groundwater dispersion modelling should be conducted for 50, 100, 500, and 1,000 years, as the site must meet environmental standards for 1,000 years.

Regulations contained in 40 CFR 192.32 specify that RCRA groundwater standards would be applicable, with radium, thorium, uranium and molybdenum added as hazardous constituents. RCRA groundwater standards would require that groundwater protection standards, as established by the Agency, be met at the downgradient boundary of the disposal cell. Since there is a mixture of hazardous constituents, and since there are no promulgated RCRA MCL's (Maximum Contaminant Level) for many of the constituents, the groundwater protection standards are likely to be ACL's (Alternative Concentration Limits) (per 40 CFR 264.94(3)). The ACL demonstration requires that the groundwater plume grows neither in concentration or areal extent. Compliance with this requirement has not been shown for the proposed site (or for the alternatives). Based on the existing information, it seems likely that the groundwater plume will grow both in concentration and areal extent, and no proposal for a corrective action has been made.

7

Therefore, the following is needed for the proposed site to be considered compliant with the groundwater standards:

- A demonstration that the existing plume of contamination will not grow, or that adequate corrective action measures will be in place. This demonstration should be equivalent to that required for a RCRA permit (guidance on the RCRA groundwater standards can be provided on request).

Surface water Impacts

The SFES did not discuss the potential impacts on Kress Creek and the West Branch of the DuPage River. These impacts must be addressed since it appears that these two waterbodies are likely groundwater discharge areas.

The SFES documents significant groundwater contamination beneath both the factory area and the disposal area (in the glacial drift aquifer and the dolomite aquifer) and states that groundwater flow in the E stratum of the glacial material and in the dolomite is toward the southwest (i.e., Kress Creek). However, the report did not address the possibility and/or significance of groundwater loadings of nonradiologic contaminants to Kress Creek although concentrations of several metals and inorganics in groundwater samples exceeded Illinois water quality standards. It is unknown whether contaminated ground water is currently discharging to and causing water quality violations in Kress Creek.

To better assess the impacts to surface water, we are requesting the following information:

- An assessment of the water quality in Kress Creek, including an estimation of the impact of continued discharges of contaminated groundwater on the Creek's water quality.
- Sediment assessments or fish tissue analyses. Contamination resulting from historic surface runoff and groundwater discharge will likely be detected only in the sediments or in fish tissue. Unless this type of information is provided, NRC cannot substantiate their assertion that site-related surface runoff has not led to contamination of the Creek.
- A discussion of what the surface water monitoring program is intended to accomplish. The program should provide a means of detecting, and therefore, preventing, contamination of Kress Creek via surface runoff and seepage of contaminated groundwater. Without the initial recognition that contaminated groundwater may lead to violations of water quality standards in Kress Creek and provisions for remediating contaminated groundwater on-site, it is unlikely that surface water monitoring data will be used for anything other than verifying contamination.
- A clarification of the Atomic Safety and Licensing Board's decision to exclude Kress Creek and the West Branch of the DuPage River soils and sediments from remediation under this project. This exclusion virtually invalidates the proposed monitoring program. In considering only threats to human health, the Board has failed to consider impacts related to fish and aquatic life and wildlife.

Although these issues have no direct bearing on the selection of a permanent storage site, they do determine the suitability of the West Chicago site for use as a permanent storage given the requirements of an effective remediation plan. There is no point in monitoring the storage facility's environmental integrity if the remediation itself is incomplete.

It is apparent from the response letter from the City of West Chicago to the NRC (contained in Appendix H of the Draft Supplement to the Final Environmental Statement) that uncertainty exists regarding the City's willingness to accept wastewater from the site under the preferred alternative. This issue needs to be resolved prior to selection of an alternative. Our Agency would also want to review any and all monitoring designs associated with surface water discharges (point and nonpoint discharges), including the actual NPDES permit if a direct discharge to surface water is contemplated.

Compliance with EPA Regulations for Long Term Maintenance

The option recommended by the NRC is disposal of the radiologically contaminated materials at the West Chicago site. The method of on-site disposal includes installation of a layered cell cap which is intended to limit Radon emission and percolation of precipitation, and to limit intrusion into the waste. The condition of this cap is critical to the long-term performance of the cell design in the protection of the public health and of groundwater quality.

The NRC avoided addressing the long term impacts of on-site disposal by assuming that the site and the cell cap would be monitored and maintained, if necessary, for 1,000 years. This is contrary to Criterion 1 of 10 CFR Part 40, Appendix A, which states, "Tailings should be disposed of in a manner that no active maintenance is required to preserve conditions of the site". Based upon the information in the SFES, the preferred disposal facility does not meet Appendix A criteria. Without ongoing active maintenance, the integrity of the cell cap is likely to be seriously compromised over the long term by erosional forces, as exacerbated by intrusion onto the site by humans and burrowing animals. The potential impacts caused by erosion of the cell cap include increased release of Radon to the public and increased water infiltration and subsequent leachate generation.

The NRC has avoided addressing and evaluating these important impacts by assuming the long-term custodian of the site would remedy any problems that arise over a 1,000 year period. For example, the NRC stated on page H-335 of the SFES that "No attempt was made to estimate potential erosional effects from gullies because it is believed that the long-term monitoring and maintenance program would prevent their development. The integrity of the cell cap could be seriously impaired at some distant time in the future if the cell were not monitored and maintained. However, the proposed long-term monitoring and maintenance program would prevent the development of gullies and other serious erosional damage." Page H-377 states, "Calculations of long-term impacts to groundwater were made under the assumption of long-term maintenance of the disposal cell for all alternatives." On that same page the SFES also states, "Root penetration should not be a problem because long-term maintenance would include maintenance of the grass cover and removal of any trees growing on the sides or top of the disposal cell that affected the integrity of the cell cover."

This approach is not acceptable to our Agency. Therefore, the following is required:

- A thorough evaluation of the long term environmental impacts of each alternative assessing the impacts over a 1,000 year period without active long term maintenance must be done. An evaluation of the environmental effects after the first 100 years following transfer of the site ownership to the long term custodian should also be included.

Guidance on this issue may be taken from 10 CFR 61.59 which states, "...institutional controls cannot be relied upon for more than 100 years following transfer of control on the disposal site to the owner." Furthermore, the Final Environmental Impact Statement for Standards for the Control of Byproduct Materials from Uranium Ore Processing (40 CFR 192) states, "Unfortunately, there is no general consensus on the length of time human institutions will remain effective or reliable to continue such active maintenance. In this regard, failure of institutional controls does not necessarily imply a complete breakdown of societal structure. The more likely situation would be failure of institutional controls through program reductions, reorganization, changes in priorities, or through failure of special funding mechanisms." (FES for 40 CFR 192, page 8-3).

Compliance with NRC Siting Criteria Regulations

Federal Regulations 10 CFR 40 Appendix A discuss site criteria for disposal of certain tailings or wastes produced by the extraction or concentration of source material from ore. The NRC has some discretion in applying the Appendix A criteria to existing sites. However, disposal plans at existing sites must meet the objectives of the criteria and "clearly demonstrate how the criteria have been addressed." (10 CFR 40 Appendix A, Introduction). "In any event, a full evaluation of tailings disposal and alternative sites must be completed at each milling operation and final plans formulated through a public decision making process." [Preamble, 45 Fed. Reg. 65,523 (October 3, 1980)].

NRC has not satisfactorily addressed the Appendix A criteria and underlying objectives. Rather than use the criteria during the actual screening process of the various alternatives, as contemplated by the Atomic Energy Act and implementing regulations, the NRC does not discuss the criteria until after it has selected the proposed action. The SFES "Alternative Site Selection Process" breaks the disposal option selection process into two phases. Phase I rates the suitability of generic categories of disposal options using three vaguely defined criteria (geological/hydrological, social/political, and economic) which do not conform to the thirteen detailed criteria in Appendix A. The SFES does not appear to discuss the criteria used in any meaningful detail. Similarly, Phase II of the selection, which analyzes individual disposal sites, does not address the Appendix A criteria or objectives until after the proposed action has been chosen. Thus, the NRC has not used the Appendix A criteria to select the proposed action.

NRC briefly discusses the Appendix A criteria in Section 2.2 of the SFES. This discussion does not constitute a detailed analysis of the Appendix A criteria. For instance, the report simply states that "The proposed action also conforms to Criteria 8 and 10 through 13" without further detail or explanation. Most seriously, the NRC does not sufficiently justify the failure to meet Criteria 1 and 3. The NRC admits that the proposed action does not meet Criterion 1 without explaining how the action would meet the objective of that criterion: permanent isolation of tailings and associated contaminants. Similarly, the cursory treatment of Criterion 3, the "prime option" for disposal of tailings, does not meet the regulatory requirement of "serious consideration of this disposal mode".

Thus, NRC has not adequately met the statutory and regulatory requirements of analyzing the disposal options according to the Appendix A criteria. If the NRC chooses to screen generic categories of options, it must do so using the Appendix A criteria. Also the final plan must contain a detailed discussion of how each option considered meets or fails to meet each Appendix A criterion or objective.

Page 1-19 of the SFES states that a proposed action can be denied for environmental reasons only if an alternative site is identified that is obviously superior. Criterion 1 of 10 CFR 40, Appendix A states that the site selection process must be an optimization, to the maximum extent reasonably achievable in terms of the features which are listed in Appendix A. If this guidance were strictly followed by NRC, then the following conclusions could be drawn: Alternatives A through D are superior to the proposed alternative in terms of remoteness from populated areas (Criterion 1). Alternatives A and D are superior to the proposed alternative because they are underlain with clay instead of sand as is the proposed alternative (Criterion 1). Alternatives A, B and C are superior to the proposed alternative because below grade disposal (the prime option of Criterion 3) is possible, whereas, the proposed alternative is erosion-prone since it is above grade (Criteria 1,3). Alternatives A through D are superior to the proposed alternative in terms of less need for ongoing maintenance of the site. The proposed alternative, which is most susceptible to erosion, will require long term monitoring and maintenance which is contrary to Criterion 1.

The difficulty with reaching these conclusions appears to be that NRC has declined to compare the proposed alternative point by point with Alternatives A through D. We are concerned that the criteria have not been applied with equal weight to the proposed alternative, making it impossible to make any determination of the most suitable site for disposal. We are also concerned that the decision not to apply these criteria to the existing site is based upon a technicality, rather than upon a primary concern for public health and safety.

Criterion 6 of Appendix A mirrors 40 CFR 192.32(b)(1) requirements for disposal areas to be designed to assure control of radiological hazards over the long term. Criterion 11 C. provides for transfer of property title to Government land ownership as a "desirable supplementary measure" to assure long-term physical isolation of tailings and other wastes. As previously discussed, the SFES does not adequately explain how the long term control will be implemented. The SFES should also discuss possible transfer of ownership to the Government as a desirable option.

The NRC should provide the following information:

- Use the criteria set forth in Appendix A to choose a proposed action or otherwise specifically address the underlying objectives set forth in the Appendix.
- Discuss how each alternative meets or fails to meet each Appendix A criterion or objective
- Discuss how long term control will be implemented and discuss transfer of ownership to the Government as a desirable option.

Transportation Costs and Health Effects

The costs of the off-site alternatives when compared with the proposed action in the SFES appear much higher. However, the cost of off-site disposal includes $26,400,000 for 55,300 LSA bins which would be used only once and buried at the alternative sites. The $26,400,000 cost constitutes a substantial proportion of the total cost of the off-site alternatives. For example, this cost constitutes 44 percent of the total cost of Alternative C. The SFES did not provide any meaningful analysis of the costs assuming that these bins could be reused. Therefore, the following information must be submitted:

- Revised project costs based upon consideration of decontamination and reuse of the transportation bins in Alternatives A-D.

The proposed alternative appears in the SFES to result in much lower radiation doses and health effects to the total affected population than those due to Alternatives A-D. We believe that radiation doses to the public, due to transportation of the waste material to alternative sites, are overestimated in the SFES through the use of a questionable assumption and a neglect of NRC's principle of maintaining doses as low as reasonably achievable (ALARA). EPA believes that sufficient low-cost dust control methods and strategies are available to reduce doses to the public from transport to virtually zero. The NRC has neglected their own Agency's principle of maintaining doses as low as reasonably achievable (ALARA). Therefore, the following information must be provided:

- Revised estimates of radiation doses to the public for all off-site Alternatives A-D, considering all economically reasonable methods to control fugitive dust emissions from the transported wastes in keeping with the NRC's principle of ALARA.

Consideration of In-Situ Vitrification Processes

Our Agency's previous comments on the Draft SFES requested that in-situ vitrification be considered to stabilize the waste and reduce potential releases. The response that this was not a sufficiently developed technology in the past is not an adequate response. This technology is sufficiently developed now for it to be a viable option for consideration. Vitrification has now become a proven technology for the treatment of radioactive wastes. As was discussed in our June 30 meeting with the NRC, the proposed closure for the REF is not keeping pace with treatment technologies which are applicable to radioactive waste. Simple containment is no longer "state of the art" and from a technical and economic point of view, may not be the best solution.

In order to address our Agency's concern that alternatives to simple containment have been given serious consideration, the following information needs to be provided:

- A complete assessment of vitrification (either in-situ or combined with removal) as a viable technology for the waste. The assessment should include all of the considerations that the other closure options addressed.
- An assessment of how volume reduction techniques, such as soil washing would effect all of the closure options. Soil washing with water only has been shown to reduce volumes by one third, with very little expense. This allows the ultimate closure costs to be lower because the primary cost is from disposal.
- A discussion of how new technologies will be considered during the closure of the REF, especially if the closure process is going to drag out for a long period of time. Our Agency believes that technologies cannot be dismissed just because Kerr-McGee has not completed closure in a timely manner.

Off-Site Waste Areas

The off-site areas which are of concern to the Agency were not adequately discussed. If the so-called "source materials" which were removed from off-site locations for storage at the Rare Earth Facility are not to be included in the decommissioning and closure activities, plans for these materials must be formulated and an assessment of the potential impacts must be undertaken. Our Agency is particularly concerned that these materials, which were generated from sites proposed for the National Priorities List (NPL), be handled in a manner consistent with the final remedies for the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites. Once a remedial investigation is started at a site proposed or finalized on the NPL, the responsible parties cannot take any actions which would interfere with our Agency's actions. The ultimate disposal or materials taken from any of the four proposed NPL sites must be consistent with the requirements of CERCLA.

In order to address these concerns, the following information is required:

- A written commitment regarding whether the off-site material which has been taken from any of the four proposed NPL sites and stock piled at the REF will be included in the final closure of the REF.

- If the material will be included in the final closure of the REF, then a demonstration of how the requirements of CERCLA will be met for the off-site material must be undertaken.
- If the material will not be included in the final closure, then details regarding the handling and storage of the off-site material must be provided. These details, at a minimum, should include: plans for keeping the off-site material isolated from the on-site material during all phases of storage and closure; plans for storage and movement of the off-site material during closure activities; plans for storage and ultimate disposal of the off-site material after closure activities for the REF are complete; and a demonstration that this material will cause no adverse impacts to public health or the environment at any time.

Resource Conservation and Recovery Act (RCRA) Issues

There are some potential RCRA issues that could effect the decommissioning work at the facility. One is that the material that was excavated from properties, the Sewage Treatment Plant and other off-site areas has not been evaluated to determine whether it is hazardous as defined by RCRA. If it is, there would be complications relating to illegal generation, storage and disposal. An evaluation has been provided which indicates that the wastes on-site are not hazardous by the characteristic of EP toxicity. A mean value for the samples is given, however, the ranges were not provided. If any single sample exceeded the allowable level in the leachate, that sample would indicate the presence of hazardous waste, which would trigger RCRA requirements. Also, other wastes are listed in Chapters 1 and 2 which might be RCRA regulated (i.e., barium sulfate). If so, discussion of how the decommissioning work will meet the RCRA closure or permit requirements should be provided (particularly in the cost analysis).

In order to assess the potential RCRA status of the REF, the following information needs to be provided:

- All of the data generated for the EP Toxicity assessment for the on-site waste including the outliers. The statistical analysis provided is not, by itself, sufficient.
- Any data, analysis or information regarding the RCRA status of the off-site material which has been stored at the REF, especially any EP Toxicity analysis.
- Any data, analysis, manifests or other information regarding the waste listed in Chapters 1 and 2, which would support their characterization as non-hazardous.

TIM-8964/3-1 Rev. 2

TECHNICAL INFORMATION MEMORANDUM: REVIEW OF KERR-McGEE WEST CHICAGO RARE EARTHS FACILITY DISPOSAL PLAN DESIGN

Prepared by:

D.E. BERNHARDT
V.C. ROGERS
R.B. KLEIN
J. DANNA
Rogers and Associates Engineering Corporation
Salt Lake City, Utah

under

Contract No. 68D90170

with

S. COHEN & ASSOCIATES, INC.
McLean, Virginia

Work Assignment No. 1-3
John L. Russell/Allan Richardson, Work Assignment Managers

Prepared for:

U.S. Environmental Protection Agency
Office of Radiation Programs
401 M Street, S.W.
Washington, D.C. 20460

April 13, 1990

TABLE OF CONTENTS

1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) has approved the Kerr-McGee Chemical Corporation proposal for on-site disposal of the thorium ore residuals from the West Chicago Rare Earths Facility (Rare Earths Facility). The U.S. Environmental Protection Agency (EPA) regulations for uranium and thorium mill tailings, 40 CFR 192, Subpart E (40 CFR 192), promulgated by EPA on October 7, 1983 (FR 48/196: 45926) specify criteria for the operation and closure of thorium milling facilities. The facility was operated under NRC license and is also to be decontaminated under NRC license, and is therefore covered by the Clear Air Act (CAA) National Emission Standards of Hazardous Air Pollutants; Radionuclides (NESHAPs) promulgated December 15, 1989, 40 CFR 61 (FR 54/240: 51654) (Note: the NESHAPs for NRC facilities were stayed until March 15, 1990).

The basic criteria of 40 CFR 192 are:

1. Limitations of radon flux to 20 pCi/sq m-sec.
2. Annual radiation doses to be less than 25 mrem whole body, and specific organ doses (other than thyroid) to be less than 25 mrem.
3. The closure should be effective for 1000 years to the extend reasonably achievable, and, in any case, at least 200 years.
4. Groundwater has to be protected, and if it has been contaminated above criteria, a corrective action program initiated.

The NESHAPs promulgated on December 15, 1989 (40 CFR 61), include criteria for the radon flux from uranium mills (40 CFR 61, Subparts T and W) and for radioactivity emissions from NRC licensed facilities (40 CFR 61, Subpart I). The radon flux criteria of Subparts T and W is only for uranium milling facilities and apparently is not applicable to the Rare Earths Facility. The criterion for radioactivity releases from NRC licensed facilities is 10 mrem/yr; for the whole-body effective dose equivalent. The criteria of 10 mrem/yr is applicable to the Rare Earths Facility, but was stayed until March 15, 1990.

1.1 OBJECTIVE

This technical memorandum provides an evaluation of the proposed closure plan to determine whether the activities will comply with the EPA 40 CFR 192 standards for closure of thorium facilities, with an emphasis on how these standards have been implemented by the Department of Energy for the Uranium Mill Tailings Remedial Action Program (DOE, UMTRAP). An assessment is also provided to evaluate the radiation releases and doses based on the NESHAPs criteria.

The assessments are based on the design information in the Supplement to the Final Environmental Statement related to the Decommissioning of the Rare Earths Facility, West Chicago, Illinois (NUREG-0904) (SFES) (NRC 89), information from prior EPA investigations at the Rare Earths Facility (Be85, CH86) and information from the Atomic Safety and Licensing Board Hearings on the decommissioning plan (ASLB90). The data base on volumes of waste material, the source terms in the SFES, and the groundwater gradient information (SFES, reference NRC89; e.g., Table 2.2, Table 2.3, and Figure 4.28) generally reflect the information from previous work for EPA (Be85, CH86) and were used in these assessments.

The design in the SFES indicates the radon flux will be adequately controlled to meet the radon flux criteria of 40 CFR 192. Additional assessments of the radon flux are outside of the scope of this evaluation.

This assessment focuses on evaluating compliance with the 40 CFR requirements for long-term effectiveness of site closure plans and groundwater protection. The assessment of long-term design is oriented toward the objectives of the U.S. Department of Energy for the Title I inactive uranium mill tailings sites under the Uranium Mill Tailings Remedial Action Program. An assessment of the radiation emission based on the criteria of the CAA NESHAPs is also provided. The long-term effectiveness of the proposed closure plan and the protection of groundwater are evaluated in Section 2. Section 3 presents information from the assessment of radiation emissions related to the NESHAPs. Section 4 provides the summary and conclusions.

2.0 IMPLEMENTATION OF 40 CFR PART 192 REGULATIONS

The radiation doses from remedial operation reported in Table 5.11 of the SFES indicate that the specific organ dose requirements of Part 192 will not be met. The doses for the bone and lung reported in Table 5.11 only account for the dose during the year of intake, and do not include biological retention of long half-life materials. The assessment of doses related to the CAA NESHAPs in Section 3 also indicates that the annual doses may be higher than those indicated by the SFES. However, a comprehensive assessment of airborne emissions and associated doses, related to Part 192, is outside of the scope of this report.

The assessments concerning compliance of the disposal design of the Rare Earths Facility with the criteria of Part 192 focus on: 1) the requirements for the long-term effectiveness of the design and 2) groundwater protection.

2.1 LONG-TERM EFFECTIVENESS OF THE PROPOSED DISPOSAL PLAN

The assessments of the long-term effectiveness of the design are based on the precepts of the DOE UMTRAP for cleanup and stabilization of inactive uranium mill tailings sites (DOE83, DOE84, DOE85, Re90). The DOE program is implementing the EPA Part 192 standards for some 24 sites and has received extensive technical peer review and oversight by the NRC and EPA. The basic criterion of the Part 192 standards is a design objective of 1000 years to the extent reasonably achievable, and a minimum of 200 years. The specified objective is to use passive design features as much as possible, with minimal reliance on active maintenance. The preamble to the Part 192 standards (FR 48/196: 45928) addresses the need for long-term isolation with passive design concepts, noting that Congress in passing the Uranium Mill Tailings Radiation Control Act in 1978 recognized that the hazard from the tailings materials will remain long after existing "institutions" can be expected to last in their present forms.

The basic concepts of long-term stability using passive designs are to use closure plans with gradual slopes and erosion resistant materials to prevent water and wind erosion. The disposal facilities are designed with covers to isolate the wastes, prevent airborne emission of the tailings, control the radon flux, and minimize infiltration of precipitation and resulting leaching of contaminants to the groundwater. The assessments have indicated that the impacts of water erosion are generally more degrading to the isolation-covers than wind erosion, and the basic design concepts have been focused on preventing water erosion, especially gullying of the cover material.

Long-term designs are generally based on using low-probability high impact events such as the Probable Maximum Precipitation (PMP), 100-year rain fall events, or variations on these (DOC82, Me76). These events are estimated for different areas of impact (e.g., one square mile) and different time periods of duration (e.g., 1 hr and 6 hr.). Techniques are also used to estimate the fraction of a PMP that may occur as an intense or peak short-term event with a duration of less than one hour. For northern Illinois it is estimated that 0.34 of the one-hour PMP may occur in 5 minutes (DOC82). Figure 1 gives the one-hour PMPs (DOC82).

2.1.1 UMTRAP Design for Long-Term Isolation

The UMTRAP covers are designed to resist wind and water erosion, minimize the infiltration of precipitation, and control the impacts from burrowing animals and deep rooted vegetation. Infiltration of precipitation is controlled by using high integrity clay caps and providing drainage layers of granular material above the clay cap. The water erosion protection layer is generally designed to resist wind erosion and also protects against burrowing animals and root penetration. Generally the erosion protection layer either protects the other features of the cover or directly provides the protection. For example, a riprap erosion protection layer protects against burrowing animals.

The DOE UMTRAP program has generally used the 1-hr PMP (DOC82) and the Manning equation to design covers and specify materials for closure of the inactive uranium mill tailings piles (DOE83, DOE84, DOE85). The cover designs are based on maximum side slopes of 20 percent grade (1 vertical to 5 horizontal), runoff velocities based on the PMP, and requirements for riprap rock size distribution to minimize erosion. The designs are generally based on the 1-hour PMP, but for Lakeview, Oregon, consideration was given to the 5-min intensity event.

A vegetative cover was proposed for the Canonsburg, Pennsylvania, site, but the primary erosion protection was provided by an 18-inch layer of pit run rock (DOE83).

Recent investigations indicate that outer rock layers do not provide the desired level of protection to intrusion by volunteer plants into the cover of sites. The DOE UMTRA program is giving more consideration to the applicability of vegetative covers on top of rock covers to control root penetration and reduce moisture penetration in the pile (Re90). By using proper design and construction of the rock layer and the overburden soil and vegetation, transpiration and drainage minimizes infiltration of precipitation. The subsequent reduced moisture and proper design of the rock layer minimize the growth of roots into the rock layer (Re90).

2.1.2 Kerr-McGee/NRC Long-Term Design of Rare Earths Facility

The SFES does not clearly describe the basis of the long-term design of the Rare Earths disposal site; therefore the information from the SFES was supplemented with information from the report of the ASLB hearing concerning the closure and decommissioning plan (ASLB90). The proposed design is apparently not based on the PMP. The ASLB indicates that the design is based on the 6-hr event which is termed the PMP-B. The 6-hr PMP-B of about 25 in, is equivalent to about 4 in/hr or about one-fourth of the 1-hr PMP of 17.6 in/hr.

The ASLB record indicates that, for the design basis of the Rare Earths Facility, the PMP-B of about 25 inches per 6-hr was further reduced by a factor of 3 to provide a design value of about 8.4 in for a 6-hour period. The ASLB compares the reduced value of 8.4 in per 6-hr (this is 1.4 in/hr) to a 200-yr design storm concept to indicate that the design meets the EPA 40 CFR 192 requirements for at least a 200-year design.

The proposed Rare Earths Facility design is based on a vegetative soil cover, over a 2-ft intrusion/erosion barrier. The intrusion/erosion barrier is specified as graded clays to cobbles (NRC89, p. 3-6 and elsewhere). Additional specification of this material was not found in the SFES. The "graded clays to cobble" layer may contain a high fraction of cobbles, and thus if the clays are eroded away provide a viable erosion barrier, but specifications are not given. Based on the description, the material may be glacial till, composed primarily of silt with interspersed cobbles.

2.1.3 Assessment of Long-Term Design of Rare Earths Facility

Table 1 provides a summary of water runoff velocities for various design values. The velocities are based on the basic topographical design of the proposed Rare Earths Facility disposal site (gradual sloping top, 20 percent grade on the sides). The calculations are based on the indicated design events, runoff over clay or grass, and calculations using the Manning equation (Me76). In addition to the PMP and the design used for the Rare Earths Facility, an estimate of the 200-yr rainfall event is provided for comparison. The 200-yr event is based on an extrapolation of the information from Merritt (Me76).

The long-term effectiveness of the design should be based on the PMP, not a modified or reduced PMP. The other entries in Table 1 are given to illustrate the proposed design for the Rare Earths Facility. The estimated 200-year event is given to illustrate that the modified PMP-B design rainfall event used for the Rare Earths Facility (ASLB90) is even less than the estimate for a 200-year reoccurring event. The runoff velocities in Table 1 are based on reasonable mid-range values. The use of a smaller area base for the PMP, short-time peaking of the PMP, or channeling of flow due to erosion or settling would produce runoff velocities up to several times higher.

The design parameters in Table 1 can be evaluated using the following recommended maximum permissible velocities from the Army Corps of Engineers (ACE70):

· Grass lined earth (sandy silt) (Keep velocities less than 5 ft/sec unless good cover and proper maintenance can be obtained)	6 ft/sec
· Clay (smooth surface)	6 ft/sec

TABLE 1

EROSION WATER VELOCITIES

Design Concept	Precipitation Base Event (inches/hr)	Erosion Water Velocity (ft/sec)	
		Smooth Clay	Grass
PMP 1-HR	17.6	5	1.2
Rare Earths Facility (Kerr-McGee/NRC) (6-hr PMP-B, reduced)	1.5	1.6	0.5
200-Year Storm (1-hr)	4	2.5	0.7

- Silty clay 3.5 ft/sec
- Poor rock (sandstone) 8 ft/sec
- Good rock (igneous or hard metamorphic) 20 ft/sec

These values are basically engineering design values. To ensure 1,000-yr effectiveness of the design, it is suggested that projected velocities be kept below these values, especially for areas where erosion can produce significant degradation. The clay value is for smooth clay. If a clay surface is exposed it will become weathered and be more analogous to silty clay.

The Part 192 regulations specify that closures should be effective for 1,000 years to the "extent reasonable achievable." The preamble for the regulations and the support documents (EPA83) indicate that the design should be based on the PMP and not depend on long-term maintenance. Good engineering design for facilities that are specified to last for 1,000 years, time periods beyond the expected lifetime of present government institutions, should not depend on active maintenance.

The SFES does not specify that the PMP was used for the design of the Rare Earths Facility (NRC89) and the ASLB report indicates that a modified PMP-B was used (ASLB90). Although the precipitation runoff parameters for a PMP event identified in this assessment are similar to design parameters recommended by the Army Corp of Engineers, the uncertainty of the estimates and lack of conservatism is such that there is not reasonable assurance that the proposed site design meets the long-term requirements of Part 192.

The vegetative cover is the primary barrier to prevent erosion. Vegetation is subject to drought, fire, and disease, and although it is possible that the vegetative cover may survive for 1,000 years, it is not reasonable certain that a high quality vegetative cover will be retained without continual maintenance. There is reference to a continuing need for maintenance in the SFES. A design which is based on the assumption of long-term maintenance is inconsistent with the intent of 40 CFR 192.

In order to provide assurance of survival of the structure for 1,000 years, there should be adequate conservatism in the design to provide a contingency for uncertainties, such as minor settlement and subsequent channeling of surface flow, and loss of vegetation due to drought or fire, etc. Although recent UMTRA assessments have indicated the desirability of vegetative covers for mill tailings sites, UMTRCA designs still include a rock protection layer (Re90).

The design of the Rare Earths Facility proposed disposal site does not meet the stated intent of the long-term design requirements in the preamble to Part 192. The facility may survive, but the design as described in the SFES does not comply with what is reasonably achievable. However, if the specifications for the graded clays/cobble barrier are revised to specify a sufficient cobble content and quality to ensure it will also function for erosion protection, the design would be adequate. The section of the disposal area that may be exposed to flood waters should also be protected with a rock barrier.

The UMTRA program design philosophy has been to use relatively simple and conservative design concepts to provide reasonable certainty of 1000-year longevity of covers. The objectives include providing designs that have good certainty of survival without active maintenance.

2.2 GROUNDWATER PROTECTION

The information in the SFES (NRC89) and other available information was evaluated to assess compliance with the groundwater protection requirements of 40 CFR 192. Part 192 specifies both the future protection of groundwater and the need to initiate protective measures for existing groundwater contamination.

2.2.1 Existing Groundwater Contamination

Review of the existing information in the SFES and work by EPA (CH86) indicates that there is existing groundwater pollution at the site. There is no information on the concentration of pertinent pollutants in off-site wells around the Rare Earths facility in the SFES. However, based on the information in the SFES, there is only limited contamination in the down gradient wells near the site boundary that is above EPA criteria of Part 192. Many of the concentrations that are above the criteria are less than values, and the concentrations are not uniformly above the criteria (NRC89, Appendix C).

Review of the existing information in the SFES and work by EPA (CH86) indicates that there is existing groundwater pollution at the site, however, contamination above EPA criteria of Part 192, beyond the site boundary, does not appear to be present. The Kerr-McGee groundwater monitoring results given in Appendix C of the SFES (NRC89) indicate on-site concentrations of As and other metals above the criteria of Part 264.94. More recent sampling for EPA in 1985 indicated concentrations at off-site locations and most on-site locations, for the eight wells sampled, were within the criteria of Table 1 of Part 264.94. A notable result was a concentration of total uranium of 670 pCi/l in the till aquifer of the central area of the proposed disposal area (CH86). The EPA sampling locations and results are given in Appendix A.

2.2.2 Groundwater Concentrations From Proposed Site Remediation

Information from the SFES was used to model future groundwater concentrations for the proposed remediation. Previous modeling efforts by NRC and Kerr-McGee have indicated that the proposed remediation will comply with the criteria of Part 192 (NRC89, ASLB90).

The projected groundwater concentrations at the site boundary were estimated using the PATHRAE-EPA computer code (Ro87) and conservative parameters. The model parameters and results are summarized in Table 2. Calculations were performed for uranium, thorium, radium-226 and -228, and stable lead and mercury. Concentrations for mercury, thorium, and Ra-228 are not given in the table because they were so low. However, the parameters for Ra-226 are given even though the concentration is also very low. There are no specific criteria for uranium, but the calculated peak concentration of 14 pCi/l (total uranium) is near proposed criteria. However, conservative transport parameters were used in the conservative PATHRAE-EPA model. The NRC assessment in the SFES indicated a total uranium concentration of about 4 pCi/l and a lead concentration of 0.011 ppm (NRC89, p. E-13 and E-16, respectively). These values are similar to the estimates in Table 2.

3.0 COMPLIANCE WITH CAA NESHAPs

Version 1.2 of the EPA COMPLY computer code was used to assess the releases of airborne emissions during remediation operations. The source term parameters were taken from the SFES, Table 5.10 (NRC90). The assessment was performed using Level 4 of the COMPLY code, and a windrose for O'Hare Airport (NOAA74).

The COMPLY computer code is oriented to stack releases. In order to model the closure activities for the Rare Earths Facility, the releases were represented as four stacks uniformly positioned on the site, with a minimum distance of 125 m to the off-site location. The off-site location was to the east of the site, one of the prevailing wind directions. The distance to farms where food was produced was set at about 1 km so that the assessment would be primarily based on the dose from inhalation of airborne material. There is not farming in the immediate downwind area of the site.

Assessments were performed for two source terms. Airborne emissions are given in Table 5.10 of the SFES for the total project (top part of the table) and for the year with the maximum release. The total period of the project is not given in the table, but other information indicates the total project period for remedial actions will be 5 to 7 years. Assessments were performed using the data for the year with the maximum release. Assessments were performed using: 1) the source terms as given in Table 5.10 and 2) the reported source terms plus source terms for U-234, Pb-210, Po-210, and Th-228 which would also be expected to be present, based on the radioactive decay chain relationships.

The estimated doses for the proposed remediation at the site are:

- Source term with all radionuclides: 72 mrem/yr
- Limited source term (Table 5.10) 22 mrem/yr

The printout from the COMPLY program for the assessment using the full source term is given in Appendix B.

4.0 SUMMARY AND CONCLUSIONS

This technical memorandum has provided an assessment of the proposed remediation of the Kerr-McGee West Chicago Rare Earths Facility. The assessment has been based on comparing the proposed action to the EPA uranium and thorium mill tailings regulations of 40 CFR 192 and the December 15,1989 Clean Air Act National Emission Standards for Hazardous Air Pollutants; Radionuclides, 40 CFR 61. The evaluation of the long-term requirements for the design considers the design concepts used in the DOE UMTRA program.

The scope-of-work for these assessments limited the review to the long-term effectiveness of the design and groundwater protection criteria of 40 CFR 192, and a brief assessment of airborne emissions for the Clean Air Act NESHAPs.

The EPA regulations in Part 192 specify that closures should be effective for 1,000 years to the "extent reasonable achievable." The SFES and other referenced information does not claim that meeting the 1,000 year requirement is not reasonably achievable. To meet these requirements a facility design should be based on the PMP and not depend on long-term maintenance. The SFES and other referenced information indicate that a reduced concept of the PMP was used for the design of the Rare Earths Facility (NRC89, ASLB90). The modified PMP used in the SFES is not an adequate design base to meet the requirements of 40 CFR 192.

The vegetative cover is the primary barrier to prevent erosion. Vegetation is subject to drought, fire, grazing, and disease, and although it is possible that the vegetative cover may survive for 1,000 years, it is not reasonably certain that a high quality vegetative cover will be retained without continual maintenance. There is reference to a need for continuing maintenance in the SFES. Such a maintenance requirement is not consistent with the stated intent of 40 CFR 192 as defined in the related preamble and Environmental Impact Statement (EPA83).

In order to provide assurance of survival of the structure for 1,000 years, there should be adequate conservatism in the design to provide a contingency for uncertainties, such as minor settlement and subsequent channeling of surface flow, and loss of vegetation due to drought or fire, etc. The Kerr-McGee/NRC design does not incorporate such conservation.

The design of the Rare Earths Facility proposed disposal site (as described in the SFES and ASLP90) does not meet the stated intent of the long-term design requirements in Part 192. Although UMTRA assessments have indicated the desirability of vegetative covers for mill tailings sites, their design still includes a rock protective layer (DOE83, DOE85, DOE90). However, if the specifications for the graded clays/cobble barrier are revised to specify a sufficient cobble content and quality to ensure it will also function for erosion protection, the design will be adequate. A properly graded rock barrier, without clay, would provide better protection against root penetration (Re90). The section of the disposal area that may be exposed to flood waters should also be protected with a rock barrier.

The assessments for groundwater protection indicate that the proposed design will comply with the 40 CFR 192 requirements for groundwater protection. The SFES only provides minimal information for assessing the need for remediation of present groundwater contamination, however the indications are that the present levels of contamination do not exceed the criteria for off-site contamination. The assessment of long-term releases to groundwater indicates concentrations of contaminants off-site will be below Part 192 criteria. However, the uranium concentrations may be above some proposed criteria.

The EPA COMPLY computer program, Level 4, indicates that the off-site doses from the maximum year of airborne emissions may be 72 mrem/yr, which is above the NESHAPs requirement of 10 mrem/yr. The general wide area emissions for the Rare Earths Facility site were modeled as four stacks distributed on the site.

REFERENCES

ACE70 Dept. of the Army Corps of Engineers, Hydraulic Design of Flood Control Channels. EM 1110-2-160, 1970.

ASLB90 Atomic Safety and Licensing Board, U.S. Nuclear Regulatory Commission, In the Matter of Kerr-McGee Chemical Corporation, West Chicago Rare Earths Facility. Docket No. 40-2061-ML, ASLB No. 83-495-01-ML, February 13,1990.

Be85 Bernhardt,D.E., V.C. Rogers, and R.B. Klein. Remedial Action Alternatives for West Chicago Wastes. Rogers and Associates Engineering, RAE-8459-1, 1985.

CH86 CH2M-Hill, Remedial Investigation Report, Kerr-McGee Radiation Sites, West Chicago,Illinois. Prepared by Rogers and Associates Engineering, WA No. 82-5L94.0, 1986.

DOC82 U.S. Department of Commerce, U.S. Department of the Army, Application of Probable Maximum Precipitation Estimates-United States East of the 105th Meridian, NOAA Hydrometeorological Report No. 52, 1982.

DOE83 U.S. Department of Energy, Final Environmental Impact Statement, Remedial Actions at the Former Vitro Rare Metals Plant Site, Canonsburg, PA. DOE/EIS-0096-F, 1983.

DOE84 U.S. Department of Energy, Environmental Assessment of Remedial Action at the Shiprock Uranium Mill Tailings Site Shiprock, New Mexico. DOE/EA-0232, 1984.

DOE85 U.S. Department of Energy, Environmental Assessment of Remedial Action at the Lakeview Uranium Mill Tailings Site Lakeview, Oregon. UMTRA-DOE/EA-0271.

Ec84 Ecker, R.M., Effects of Rock Riprap Design Parameters on Flood Protection Costs for Uranium Tailings Impoundments.

EPA83 U.S. Environmental Protection Agency, "Final EIS for Standards for the Control of Byproduct Materials from Uranium Ore Processing (40 CFR 192)," EPA 520/1-83-008-1, 1983.

Me76 Merritt, F.S. (editor), **Standard Handbook for Civil Engineers**. 1976.

NOAA74 National Oceanographic and Atmospheric Agency, O'Hare, Illinois Seasonal and Annual Wind Direction by Pasquill Stability Classes, Star Program, 1970 to 1974. Job No. 15938.

NRC89 U.S. Nuclear Regulatory Commission, Supplement to the Final Environmental Statement, Related to the Decommissioning of the Rare Earths Facility, West Chicago, IL. NUREG-0904, Supplement No. 1.

Re90 Reith, C.C. and J.A. Caldwell, Vegetative Covers for Uranium Mill Tailings. Paper at Waste Management 90 (to be published in proceedings), Tucson, AZ, February 1990.

Ro87 Rogers, V.C., and C. Hung, "PATHRAE-EPA: A Low-Level Radioactive Waste Environmental Transport and Risk Assessment Code," Rogers and Associates Engineering Corporation, RAE-8706/1-7, EPA-520/1-87-028, 1987.

APPENDIX A

RESULTS OF GROUNDWATER SAMPLING

TAKEN FROM REMEDIAL INVESTIGATION REPORT
KERR-MCGEE RADIATION SITES, WEST CHICAGO, ILLINOIS

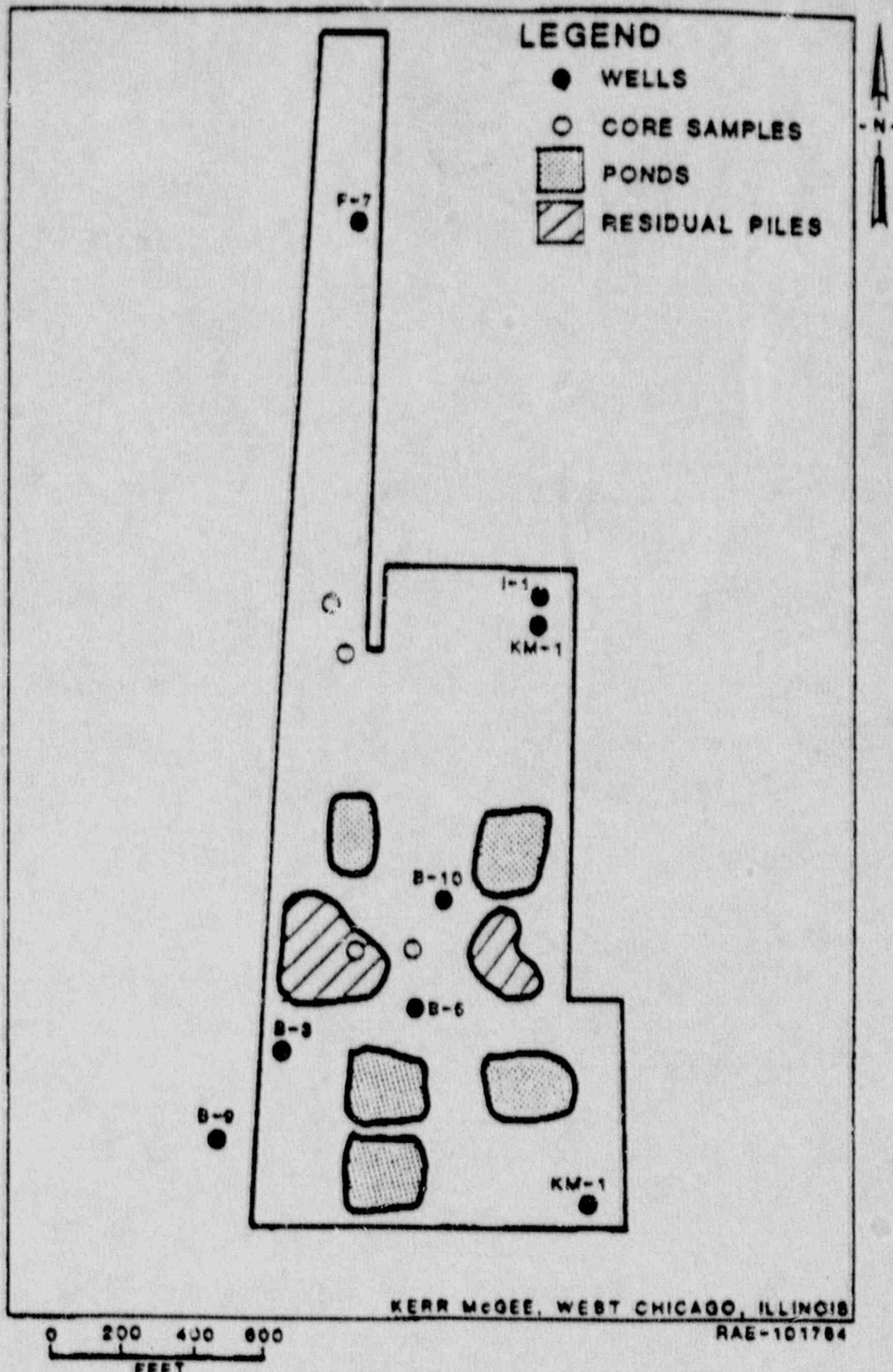


FIGURE 4-1. RARE EARTHS FACILITY SAMPLING LOCATIONS.

TABLE 4-1

GROUNDWATER ANALYSES FOR REF ON-SITE WELLS - NOVEMBER 1985

Substance Units	Up-gradient Dolomite[d]	Up-gradient Till[d]	Down Till[e]	Down Till	Down Dolomite	Down Till	Till	Down Till	Drinking Water Standards
	KME-1	T-1	B-9	B-5	KM-1	B-10	F-7	B-3	--
As ppm	<0.005	<0.008	<0.007	<0.005	<0.005	<0.005	<0.[illegible]	<0.005	0.05[a]
Ba ppm	<0.08	<0.080	<0.08	<0.08	<0.08	<0.08	<0.80	<0.08	1.0[a]
Cd ppm	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	~~<0.05~~	<0.005	0.01[a]
Cr ppm	<0.009	<0.009	<0.01	<0.009	<0.009	<0.01	0.09	<0.01	0.05[a]
Fe ppm	3.7	0.3	0.1	0.1	2.0	0.4	~~[illegible]~~	0.2	0.3[b]
Pb ppm	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05[a]
Hg ppm	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.002[a]
Se ppm	<0.003	<0.003	<0.003	<0.003	<0.003	<0.006	<0.03	<0.003	0.01[a]
Ag ppm	<0.006	<0.006	<0.006	<0.006	<0.08	<0.006	<0.06	<0.006	0.05[a]
TDS ppm	64	26	770	1,700	370	7	330	14	--
Th-232 pCi/l	0.05	<0.03	0.1	1.4	0.3	0.2	0.3	<0.3	2[c]
U-238 pCi/l	0.2	2.6	2.3	5.5	0.1	330	0.84	2.4	5[c]
U-234 pCi/l	0.4	2.8	2.8	5.9	0.2	340	1.0	2.7	5[c]
Ra-226 pCi/l	--	0.4	1.3	0.9	--	0.1	0.1	<0.2	5[a]

a. EPA Primary drinking water standard.
b. EPA Secondary drinking water standard.
c. Conceptual value developed for comparison (see Chapter 3).
d. Up-gradient well, completed in dolomite bedrock, or over burden till.
e. Down-gradient wells, completed in dolomite or till.

APPENDIX B

ASSESSMENT OF AIRBORNE RELEASES DURING REMEDIATION

USING EPA COMPLY CODE

RARE EARTHS FACILITY

WEST CHICAGO, ILLINOIS

REPORT ON COMPLIANCE WITH

THE CLEAN AIR ACT LIMITS FOR RADIONUCLIDE EMISSIONS

FROM THE COMPLY CODE, VERSION 1.0, SEPT. 1989

Prepared by:

RAE
SALT LAKE CITY, UTAH

D.S. BERNHARDT
801/262-1600

Prepared for:

U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

SCREENING LEVEL 4

DATA ENTERED:

RELEASE RATES FOR STACK 1.

Nuclide		Release Rate (curies/YEAR)
U-238	Y	3.700E-04
U-234	Y	3.700E-04
TH-230	W	2.200E-04
RA-226	W	4.500E-04
PB-210	D	3.600E-04
PO-210	D	3.600E-04
TH-232	W	1.900E-04
RA-228	W	3.000E-07
TH-228	Y	3.000E-07

RELEASE RATES FOR STACK 2.

Nuclide		Release Rate (curies/YEAR)
U-238	Y	3.700E-04
U-234	Y	3.700E-04
TH-230	W	2.200E-04
RA-226	W	4.500E-04
PB-210	D	3.600E-04
PO-210	D	3.600E-04
TH-232	W	1.900E-04
RA-228	W	3.000E-07
TH-228	Y	3.000E-07

RELEASE RATES FOR STACK 3.

Nuclide		Release Rate (curies/YEAR)
U-238	Y	3.700E-04
U-234	Y	3.700E-04
TH-230	W	2.200E-04
RA-226	W	4.500E-04
PB-210	D	3.600E-04
PO-210	D	3.600E-04
TH-232	W	1.900E-04
RA-228	W	3.000E-07

TH-228 Y 3.000E-07

RELEASE RATES FOR STACK 4.

Nuclide		Release Rate (curies/YEAR)
U-238	Y	3.300E-04
U-234	Y	3.300E-04
TH-230	W	3.200E-04
RA-226	W	4.500E-04
PB-210	D	3.600E-04
PO-210	D	3.600E-04
TH-232	W	1.900E-04
RA-228	W	3.000E-07
TH-228	Y	3.000E-07

SITE DATA FOR STACK 1.

Release height 1 meters.

Building height 0 meters.

Stack diameter 1.00 meters.

Default volumetric flow rate from the stack not used.
Volumetric flow rate is 0.100 cu m/sec.

STACK DISTANCES, FILE: WINDROSE

DIR FROM	Distance (meters)
N	200.000
NNE	200.000
NE	200.000
ENE	200.000
E	200.000
ESE	200.000
SE	200.000
SSE	200.000
S	[illegible]

SSW	[illegible]
SW	125,000
WSW	200,000
W	200,000
WNW	200,000
NW	200,000
NNW	200,000

SITE DATA FOR STACK 2.

Release height 1 meters.

Building height 0 meters.

Stack diameter 1.00 meters.

Default volumetric flow rate from the stack not used.
Volumetric flow rate is 0.100 cu m/sec.

STACK DISTANCES. FILE: WINDROSE.UCD

DIR FROM	Distance (meters)
N	200.000
NNE	200.000
NE	200.000
ENE	200.000
E	200.000
ESE	200.000
SE	200.000
SSE	200.000
S	400.000
SSW	200.000
SW	200.000
WSW	200.000
W	200.000
WNW	200.000
NW	200.000
NNW	200.000

SITE DATA [illegible]

Release height 1 meters.

Building height 0 meters.

Stack diameter 1.00 meters.

Default volumetric flow rate from the stack not used.
Volumetric flow rate is 0.100 cu m/sec.

01/01/80 00:02

STACK DISTANCES. FILE: WINDROSE.00?

DIR FROM	Distance (meters)
N	200.000
NNE	200.000
NE	200.000
ENE	200.000
E	200.000
ESE	200.000
SE	200.000
SSE	200.000
S	200.000
SSW	200.000
SW	200.000
WSW	200.000
W	180.000
WNW	200.000
NW	200.000
NNW	200.000

[illegible] 4.

Release height 1 meters.

Building height 0 meters.

Stack diameter 1.00 meters.

Default volumetric flow rate from the stack not used.
Volumetric flow rate is 0.100 cu m/sec.

STACK DISTANCES. FILE: WINDROSE.004

DIR FROM	Distance (meters)
N	200.000
NNE	200.000
NE	200.000
ENE	200.000
E	200.000
ESE	200.000
SE	200.000
SSE	200.000
S	200.000
SSW	200.000
SW	200.000
WSW	200.000
W	100.000
WNW	200.000
NW	200.000
NNW	200.000

WINDROSE DATA, MODIFIED FILE: WINDROSE.CA

Source of wind rose data: O HARE STATION #94846 CHICAGO, IL

Dates of coverage: 1/70 - 12/74

Wind rose location:

Distance to facility: 10 MILES

Percent calm: 0.01

Wind FROM	Frequency	Speed (meters/s)
N	0.056	4.64
NNE	0.060	4.86
NE	0.048	4.87
ENE	0.079	4.96
E	0.026	4.90
ESE	0.034	4.19
SE	0.070	3.83
SSE	0.045	4.1[illegible]
S	0.125	[illegible]
SSW	0.080	4.[illegible]
SW	0.079	4.79
WSW	0.090	4.54
W	0.107	4.43
WNW	0.073	4.17
NW	0.041	4.75
NNW	0.047	[illegible]

Distance from the SOURCE to the FARM producing
VEGETABLES is 2000 meters.   Stack number 1.

Distance from the SOURCE to the FARM producing
MILK is 2000 meters.   Stack number 1.

Distance from the SOURCE to the FARM producing
MEAT is 2000 meters.   Stack number 1.

Distance from the SOURCE to the FARM producing
VEGETABLES is 2000 meters.   Stack number 2.

Distance from the SOURCE to the FARM producing
MILK is 2000 meters.   Stack number 2.

Distance from the SOURCE to the FARM producing
MEAT is 2000 meters.   Stack number 2.

Distance from the SOURCE to the FARM producing
VEGETABLES is 2000 meters.   Stack number 3.

Distance from the SOURCE to the FARM producing
MILK is 2000 meters.   Stack number 3.

Distance from the SOURCE to the FARM producing
MEAT is 2000 meters. Stack number 3.

Distance from the SOURCE to the FARM producing
VEGETABLES is 2000 meters. Stack number 4.

Distance from the SOURCE to the FARM producing
MILK is 2000 meters. Stack number 4.

Distance from the SOURCE to the FARM producing
MEAT is 2000 meters. Stack number 4.

NOTES:

Default air temperature used (55.0 degrees F).

Default stack temperature used (55.0 degrees F). Stack 1.

The receptor exposed to the highest concentration is located
125. meters to the NE. Stack 1.

Default stack temperature used (55.0 degrees F). Stack 2.

The receptor exposed to the highest concentration is located
200. meters to the E. Stack 2.

Default stack temperature used (55.0 degrees F). Stack 3.

The receptor exposed to the highest concentration is located
180. meters to the E. Stack 3.

Default stack temperature used (55.0 degrees F). Stack 4.

The receptor exposed to the highest concentration is located
100. meters to the E. Stack 4.

He gets his VEGETABLES from a farm located
2000. meters to the N.

He gets his MEAT from a farm located
2000. meters to the N.

He gets his MILK from a farm located
2000. meters to the N.

Input parameters outside the "normal" range:

Building is unusually SHORT.

Release height is unusually LOW.

RESULTS:

WHOLE BODY dose: 71.6 (mrem/year).

*** FAILED at level 4.

This facility is NOT in COMPLIANCE.

Please send this report to your regional EPA office.

You may contact your regional EPA office to determine further action

********** END OF COMPLIANCE REPORT **********

FINAL REPORT

KERR-McGEE CHEMICAL CORPORATION
RARE EARTHS FACILITY

EVALUATION OF RESISTANCE TO EROSION

PREPARED FOR:

REGION V

U.S. ENVIRONMENTAL PROTECTION AGENCY
(EPA CO. 68D90130, DELIVERY ORDER NO. 3)

PREPARED BY:

NUS CORPORATION
910 CLOPPER ROAD
GAITHERSBURG, MD 20877-0962

May 4, 1990

Kerr-McGee Chemical Corporation

Rare Earths Facility

Evaluation of Resistance To Erosion

TABLE OF CONTENTS

FIGURES

Kerr-McGee Chemical Corporation

Rare Earths Facility

Evaluation of Resistance To Erosion

TABLE OF CONTENTS (cont'd)

TABLES <u>page</u>

Kerr-McGee Chemical Corporation

Rare Earths Facility

Evaluation of Resistance To Erosion

1.0 INTRODUCTION

The Kerr-McGee Chemical Corporation (Kerr-McGee) has proposed to construct a landfill/above-ground vault (disposal cell) at the Rare Earths Facility in West Chicago, Illinois. This facility will be used to dispose of thorium ore residues from the Rare Earths Facility. The U.S. Environmental Protection Agency (EPA) requested that NUS Corporation (NUS) evaluate the design of the proposed disposal cell for resistance to erosion for the Probable Maximum Precipitation (PMP) event. This report details the activities performed by NUS and summarizes the results of the evaluation.

Specific activities required as part of this evaluation include the following:

- Determine the duration and magnitude of the PMP using procedures and assumptions, as adopted by the U.S. Department of Energy (DOE) for inactive uranium sites (Title I sites), as defined in the Uranium Mill Tailings Radiation Control Act (UMTRA).
- Develop a design storm consisting of rainfall intensities versus time-of-concentration for the PMP.
- Evaluate the erosion potential of the cover system under overland "sheet" flow conditions during the PMP. Vegetative cover conditions used for analysis include turf and bare earth.
- Evaluate the erosion potential of the cover system under shallow concentrated flow conditions during the PMP. Proposed vegetative cover conditions used for analysis include tall grass prairie, wooded (forest), and bare earth.
- Evaluate the erosion potential of the circumferential drainage channels during the PMP. Proposed channel vegetative cover conditions used for analysis include tall grass prairie, wooded (forest), and bare earth.
- Calculate the factor-of-safety of the cover system assuming full saturation of the cap material.
- Evaluate the capacity of the proposed detention/sedimentation pond spillway to pass the runoff generated by the PMP.

Three vegetative cover conditions have been used to evaluate the erosion potential of the cover system, perimeter drainage channels, and detention/sedimentation pond spillway. These conditions are:

- Tall Grass Prairie
- Wooded (forest)
- Bare Earth

Since the closure design is required to be effective for 1,000 years (40CFR Part 192.32(b)), the selection of these three conditions was based on the proposed vegetative covers, tall grass prairie and wooded (forest), that may exist, in whole or in part, during the 1,000 year period after closure, and bare earth conditions which may also exist on portions of the disposal cell cover as a result of fire, drought, or disease.

2.0 BACKGROUND

The Kerr-McGee Rare Earths Facility is located in the city of West Chicago in DuPage County, Illinois. The facility began operations in 1931 and closed in 1973. During the operating period, various chemical processes were used to produce thorium and rare earth compounds. The waste materials produced by the processing activities include sands, sludges, and sediments.

In 1979, Kerr-McGee submitted a stabilization plan to the U.S. Nuclear Regulatory Commission (NRC) for decommissioning the inactive Rare Earths Facility. Since this submission, a Final Environmental Statement (FES), (NRC, 1989), was prepared by the NRC to address various disposal options for the accumulated wastes and tailings. The FES proposed that a disposal cell be approved for on-site storage of the thorium ore residuals and other wastes. It was also proposed to defer a decision on the permanent disposal method until additional monitoring data could be accumulated and evaluated with respect to the stabilization plan.

Criteria promulgated by EPA in 40 CFR Part 192 for stabilization and closure of tailings from uranium and thorium mills (40 CFR Part 192.32(b)) require the closure design to be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. The Uranium Mill Tailings Remedial Action Project developed the Technical Approach Document (TAD), (DOE, 1989), to describe the general technical approaches and design criteria adopted by the DOE to implement remedial actions plans and final designs that comply with EPA Standard 40 CFR 192. Therefore, the evaluation summarized in this report was performed in accordance with the criteria outlined in the TAD and supplemented with accepted engineering procedures where applicable.

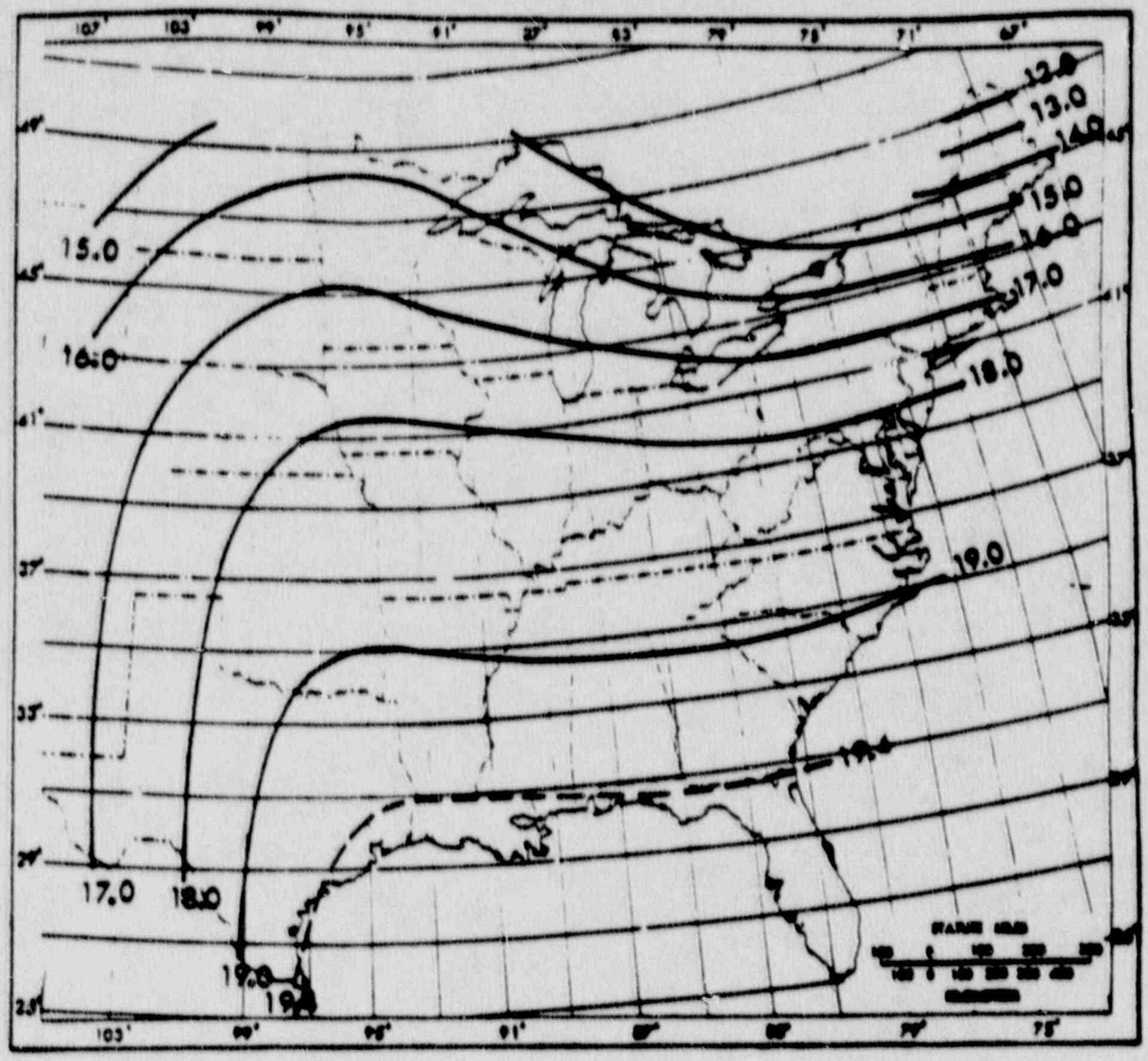
3.0 PROBABLE MAXIMUM PRECIPITATION DETERMINATION

In providing engineering designs for long-term performance to meet EPA Standards, the TAD recommends using the Probable Maximum Precipitation (PMP) event to evaluate the disposal cell cover design. The TAD recommends using the National Oceanic and Atmospheric Administration (NOAA) Hydrometeorological Report No. 52 (HMR 52), (DOC, 1982), to obtain depth-area curves for determining the PMP. The 1-hour, 1-square mile PMP storm was developed by NOAA for point or 1-square mile precipitation events and was intended for use with drainage areas of 1-square mile and less. Since the proposed disposal cell is approximately 25-acres, the 1-hour, 1-square mile PMP storm is considered the appropriate storm duration and area of influence for this evaluation. The selection of the 1-hour, 1-square mile PMP storm is also consistent with the methodology presented in the TAD. The 1-hour, 1-square mile PMP obtained from Figure 1 for evaluating the Rare Earths Facility is 17.5 inches total rainfall.

4.0 DESIGN STORM

To evaluate the design of the proposed disposal cell for resistance to erosion from the PMP, an incremental rainfall magnitude for various rainfall durations was required. The TAD provides incremental rainfall duration percentages in Section 4.2. The percentages provided in the TAD, based on Hydrometeorological Report No. 49, (DOC, 1977), were developed for the Colorado River and Great Basin Drainages. Since these areas are physiographically different than the West Chicago area, these percentages were considered inapplicable for the Kerr-McGee Rare Earths Facility site. Therefore, a more appropriate reference, Hydrometeorological Report No. 52, (DOE, 1982), Application of PMP Estimates - U.S. East of the 105th Meridian, was used to determine the incremental rainfall duration percentages for the 1-hour PMP. The incremental rainfall duration percentages are presented in Table 4.1.

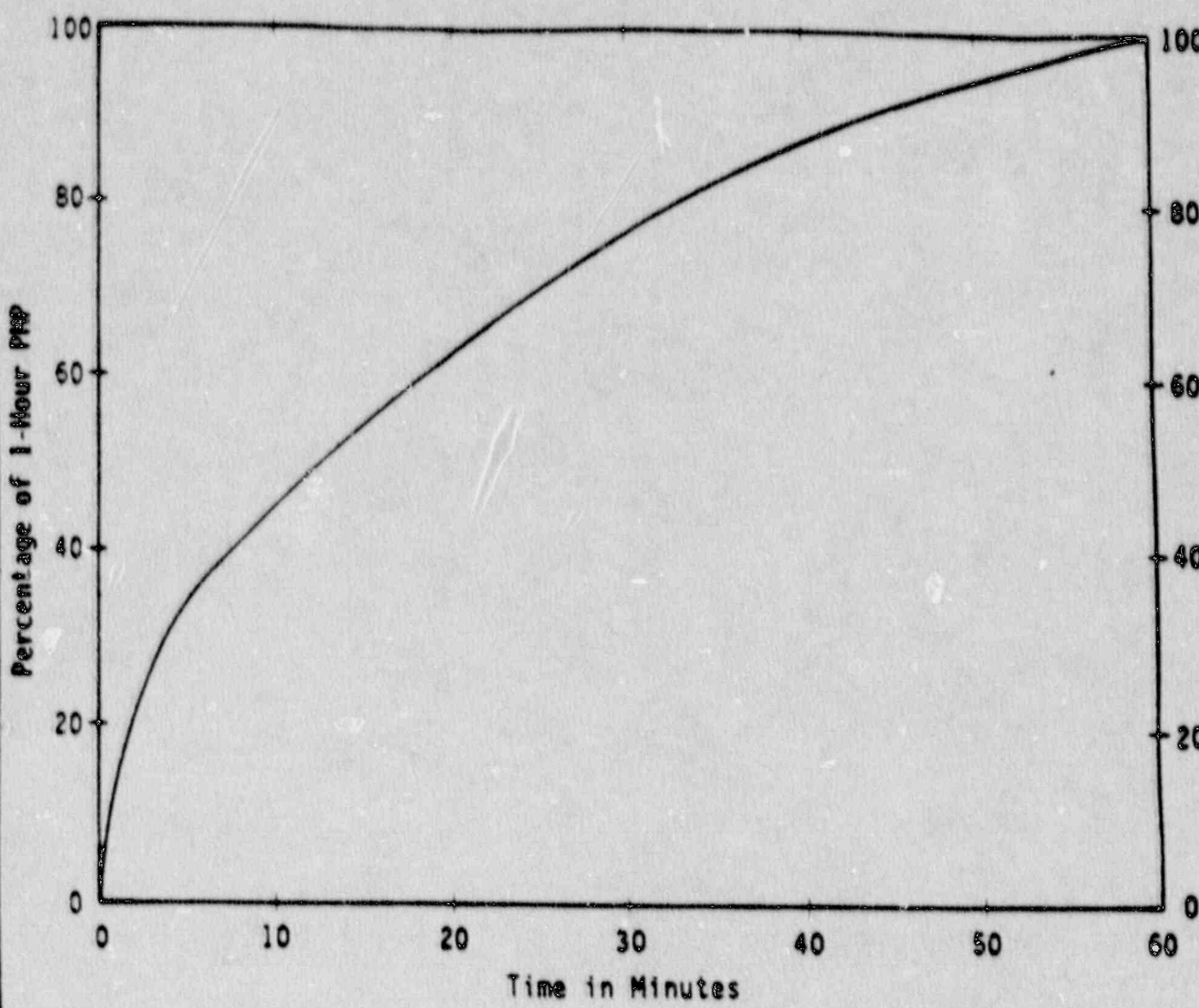
Figure 2 provides a graphical representation of the percentage of 1-hour PMP versus rainfall duration. This figure was utilized to determine the percentage of the PMP for the rainfall duration (i.e., time-of-concentration) for each evaluation performed. The minimum time-of-concentration recommended for use by the TAD is 2.5 minutes. Therefore,the time-of-concentration used in each evaluation was equal to or greater than 2.5 minutes, except for the evaluation of erosion potential



Source: NOAA Hydrometeorologic Report No. 52, (DOC, 1982).

1-Hour, 1 Square Mile Probable Maximum Precipitaion (PMP)

Figure 1.



Source: derived from data provided in NOAA Hydrometeorologic Report No. 52, 1982, (DOC, 1982).

Percentage of 1-Hour PMP versus Rainfall Duration | Figure 2.

TABLE 4.1

INCREMENTAL RAINFALL DURATION PERCENTAGES

Rainfall Duration	Percentage of 1-hour PMP	PMP (inches)
5.0 minutes	33.8%	5.9
15.0 minutes	52.7%	9.3
30.0 minutes	74.6%	13.4
60.0 minutes	100.0%	17.5

based on sheet flow. A discussion of the method used to determine the time-of-concentration and associated rainfall intensity used for determining sheet flow velocity is presented in the following section.

5.0 SHEET FLOW

The proposed disposal cell is designed to have a three percent cap slope and 20 percent (five horizontal to one vertical) sideslopes. The sheet flow time-of-concentration is calculated by the following equation (DOE, 1989):

$$tc = C(L/Si^2)^{1/3} \qquad \text{(Equation 1)}$$

where:

- tc = Time-of-Concentration (minutes)
- C = Coefficient (0.5 for paved surfaces; 1.0 for bare earth; 2.5 for turf)
- L = Distance of Flow (feet)
- S = Slope of Surface (feet/foot)
- i = Rainfall Intensity (inches/hour)

The time-of-concentration is the time required for runoff to travel from the most remote point in the drainage area to the outlet of interest. The rainfall intensity (i) is the maximum intensity which will occur during the design storm, based on a time interval equal to the time-of-concentration for the drainage area. Therefore, time-of-concentration and rainfall intensity are dependent upon each other. Since Equation 1 includes both the time-of-concentration and rainfall intensity and that these two factors are dependent upon each other, the equation must be solved iteratively (i.e., trial and error). This method results in a calculated time-of-concentration that is less than the 2.5 minutes recommended by the TAD for the bare earth conditions (cap and sideslopes) and turf sideslope condition, thus is more conservative than using a time-of-concentration of 2.5 minutes.

The time-of-concentration was calculated for the proposed disposal cell cap and sideslopes by Equation 1 for bare earth and turf conditions. The Soil Conservation Service, Technical Release 55, (DOA, 1986), recommends limiting the distance of sheet flow to 300 feet, since sheet flow usually becomes shallow concentrated flow after a maximum of 300 feet. Therefore, the maximum distance assumed for sheet flow was 300 feet for the proposed disposal cell cap. The maximum distance for sheet flow for the proposed disposal cell sideslopes is 220 feet.

The average sheet flow velocity for each condition considered was calculated by dividing the distance of flow by the calculated time-of-concentration. Proposed vegetative cover conditions assumed for the disposal cell are tall grass prairie, and bare earth. Maximum permissible velocities for these exact conditions were not available in the referenced literature.

Maximum permissible velocities for different vegetative cover conditions vary based on the source of reference. The difference in maximum permissible velocity recommended by the references is typically based on the degree of conservatism used by the author. Since the proposed vegetative conditions, (tall grass prairie, wooded [forest], and bare earth), are not specifically addressed by the references, comparable cover conditions were used for comparison in this evaluation.

Tall grass prairie, sometimes called "true prairie" or "Midwest grasses", generally consists of the following groupings (Oosting, 1956):

- Wheatgrasses
- Little Bluestem
- Kentucky Bluegrass
- Indiangrass
- Switchgrass
- Blue Grama
- Sideoats Grama

These groupings have a moderate to high degree of vegetal retardance. Therefore, the cover condition assumed for the proposed disposal cell for determining the maximum permissible velocity for tall grass prairie and wooded (forest) is Kentucky Bluegrass. Table 5.1 presents the maximum permissible velocities for the proposed cover system based on vegetative conditions, as proposed by two references, and as recommended for this evaluation.

As indicated in Table 5.1, maximum permissible velocities for Kentucky Bluegrass should not exceed 5 feet per second unless a good cover and proper maintenance can be implemented. Since this facility is designed to be maintenance free, for evaluation of erosion potential, the recommended maximum permissible velocity for Kentucky Bluegrass assumed is 5 feet per second, as recommended by Chow, 1959. This value shall be the criteria used to evaluate the proposed disposal cells design for resistance to erosion. Exceeding this value does not necessarily mean that erosion will occur, but the value should be used as the standard for which the design should comply to provide an acceptable margin of safety against erosion.

TABLE 5.1
MAXIMUM PERMISSIBLE VELOCITIES

Slope	Assumed Vegetative Condition	Maximum Permissible Velocity (*)		
		(EPA, 1985)	(Chow, 1959)	Recommended
Cap (3% slope)	Kentucky Bluegrass (Tall Grass Prairie)	7 fps	7 fps	5 fps
	Firm Loam (Bare Earth)	n/a	2.5 fps	2.5 fps
Sideslopes (5:1 slope)	Kentucky Bluegrass (Tall Grass Prairie)	5 fps	5 fps	5 fps
	Firm Loam (Bare Earth)	n/a	2.5 fps	2.5 fps
Channels (1% slope)	Kentucky Bluegrass (Tall Grass Prairie)	5 fps	5 fps	5 fps
	Firm Loam (Bare Earth)	n/a	2.5 fps	2.5 fps
Spillway	Kentucky Bluegrass (Tall Grass Prairie)	5 fps	5 fps	5 fps
	Firm Loam (Bare Earth)	n/a	2.5 fps	2.5 fps

(*) The permissible velocities apply to average, uniform stands of each type of cover. Permissible velocities exceeding 5 feet per second should only be used where good covers and proper maintenance can be obtained.

Since the top two feet of the cover system is proposed to be topsoil, the recommended maximum permissible velocity for the bare earth condition was based on ordinary firm loam and for this evaluation is 2.5 feet per second, as recommended by Chow, 1959.

Table 5.2 presents the calculated velocities, based on the calculated time-of-concentration, for the proposed disposal cell cap, sideslopes, and the recommended maximum permissible velocities for tall grass prairie and bare earth.

TABLE 5.2
SHEET FLOW VELOCITIES

Slope	Assumed Vegetative Condition	Sheet flow Velocity (fps)	Recommended Maximum Permissible Velocity
Cap	Turf	2.0	5 fps
(3% slope)	Bare Earth	8.3	2.5 fps
Sideslopes	Turf	4.9	5 fps
(5:1 slope)	Bare Earth	16.7	2.5 fps

For comparison, the sheet flow velocities for turf and bare earth conditions, based on the TAD's minimum recommended time-of-concentration of 2.5 minutes are as follows:

Condition	Velocity
Turf (cap)	2.0 fps
Bare Earth (cap)	4.9 fps
Turf (sideslopes)	3.0 fps
Bare Earth (sideslopes)	7.6 fps

For the PMP event, the sheet flow velocities for turf conditions based on the calculated time-of-concentration are below the recommended maximum permissible velocity. For the bare earth conditions, the sheet flow velocities based on the calculated time-of-concentration exceed the recommended maximum permissible velocity.

6.0 SHALLOW CONCENTRATED FLOW

6.1 Average Shallow Concentrated Flow Velocity Method

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow (DOA, 1986). To determine the velocity for estimating travel time for shallow concentrated flow, Figure 3 (McCuen, 1989) was used. Table 6.1 identifies the average shallow concentrated flow velocity for the proposed vegetative conditions assumed (tall grass prairie, wooded [forest] and bare earth). The assumed land use/flow regime selected from Figure 3 for the proposed vegetative condition is also identified.

The average shallow concentrated flow velocities, based on Figure 3, for tall grass prairie and wooded (forest), do not exceed the recommended maximum permissible velocity (5.0 feet per second) presented in Table 5.1. The average shallow concentrated flow velocities, based on Figure 3, for bare earth only exceeds the recommended permissible velocity (2.5 feet per second) for the disposal cell sideslopes.

It should be noted that Figure 3 is generally used to determine average flow velocities for calculating the time-of-concentration for watersheds. The figure does not take into consideration the magnitude or duration of the precipitation event. Therefore, the actual velocities resulting from the PMP may be higher or lower than the values obtained from Figure 3.

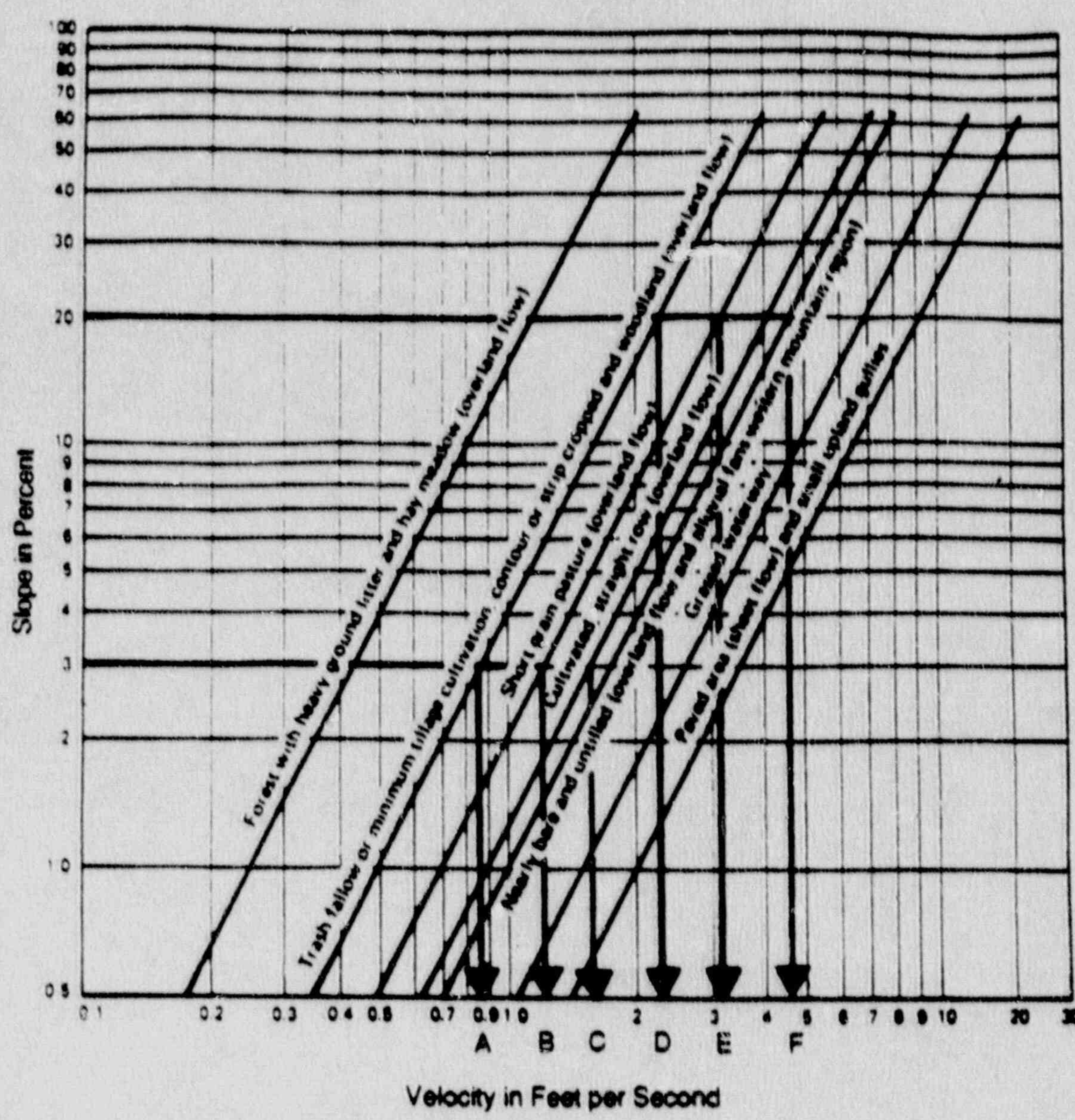
TABLE 6.1

AVERAGE SHALLOW CONCENTRATED FLOW VELOCITIES

Slope	Proposed Vegetative Condition	Assumed Land Use/Flow Regime	Average Flow Velocity
Cap (3% slope)	Tall Grass Prairie	Short Grained Pasture	1.2 fps
	Wooded (forest)	Woodland	0.85 fps
	Bare Earth	Nearby Bare and Untilled	1.8 fps
Sideslopes (5:1 slope)	Tall Grass Prairie	Short Grained Pasture	3.1 fps
	Wooded (forest)	Woodland	2.2 fps
	Bare Earth	Nearby Bare and Untilled	4.6 fps

6.2 Uniform Surface Flow Method

Since the average shallow concentrated flow velocity obtained by Figure 3 may not be representative of the sideslope flow velocity occurring during the PMP, an approach assuming uniform flow over the



Point	Slope	Velocity (Ft/Sec)
A	3%	0.85
B	3%	1.2
C	3%	1.8
D	20%	2.2
E	20%	3.1
F	20%	4.6

Source: Hydrologic Analysis and Design, R.H. McCuen, 1989.

Velocities for Estimating Travel Time for Shallow Concentrated Flow

Figure 3.

disposal cell surface was utilized. This approach assumed a channel of unit width (i.e., one-foot wide) and 600 feet in length under uniform flow conditions. The length was selected based on a time-of-concentration of 2.5 minutes and an average flow velocity of 4 feet per second. The selected 2.5 minute time-of-concentration is the minimum permitted by the TAD and is considered a conservative assumption for this method of analysis.

To determine the flow velocity for the unit width channel, the Rational Method, (Equation 2), (McCuen, 1989), and Manning's Equation for Uniform Flow, (Equation 3), (Chow, 1959), were used. The Rational Method is the most common method for determining peak runoff from drainage areas less than 200 acres. Manning's Equation for Uniform Flow is the accepted method for determining flow velocity under uniform flow conditions. Therefore, this approach was considered more appropriate than the method presented by Figure 3, since it takes into consideration the duration and magnitude of the rainfall event.

<u>Rational Method Formula:</u>

$$Q = CiA \qquad \text{(Equation 2)}$$

where

Q = Peak Runoff Rate (cubic feet per second)

C = Runoff Coefficient (dimensionless)

i = Average Rainfall Intensity (inches per hour), lasting for a critical period of time, t_c

t_c = Time-of-Concentration

A = Size of Drainage Area (acres)

<u>Manning's Equation for Uniform Flow:</u>

$$V = (1.49 R_h^{2/3} S_o^{1/2})/n \qquad \text{(Equation 3)}$$

where

V = Velocity (feet per second)

R_h = Hydraulic Radius (square feet/foot)

S_o = Slope of Surface (feet/foot)

n = Manning's Coefficient of Roughness

Table 6.2 presents the sideslope uniform flow velocities and flow depths for the unit width channel for the PMP rainfall event. In addition, the assumed Manning's Coefficient of Roughness ("n" value) and the Rational Method runoff coefficient ("C" value) are identified.

TABLE 6.2

SIDESLOPE UNIFORM FLOW VELOCITIES

Assumed Vegetative Condition	Manning's "n" Value (*)	"C" Value (**)	Flow Depth (feet)	Flow Velocity (fps)
High Grass	0.035	0.37	0.11	4.4
Timber	0.100	0.18	0.13	1.8
Bare Earth	0.022	0.50	0.10	6.5

(*) Manning's "n" Value is from (Chow, 1959)

(**) "C" value is based on Hydrologic Group B, Table 7-2, (McCuen, 1989)

As presented in Table 6.2, the sideslope flow velocity for the PMP under high grass and timber conditions is less than the recommended maximum permissible velocity (5.0 feet per second) shown in Table 5.1. The sideslope velocity for the PMP under earth conditions exceeds the recommended maximum permissible velocity (2.5 feet per second) shown in Table 5.1.

7.0 CIRCUMFERENTIAL DRAINAGE CHANNELS

Two proposed circumferential drainage channels collect runoff from the disposal cell cap and divert the runoff to the proposed detention/sedimentation pond. The capacity of the drainage channels to collect and transport the runoff associated with the PMP was evaluated. The Rational Method (Equation 2) was used to determine the peak flow rate based on a calculated time-of-concentration of 30 minutes for each drainage area. Meadow and forest conditions were assumed for determining the runoff coefficient "C" value for the proposed disposal cell. Vegetated conditions for the drainage channels were uncut weeds and brush, and bare earth.

Since the probability is low that the entire disposal cell would be bare during the PMP event, calculation of the peak flow rate in each drainage channel, assuming bare earth conditions across the entire disposal cell surface, was not performed. Assumed vegetative conditions for the drainage channels were uncut weeds and brush, and bare earth. Had bare earth conditions been assumed across the entire disposal cell for the bare earth drainage channel evaluation, peak flow rates, flow velocities, and flow depth would have been greater than for the assumed vegetative conditions.

To determine the adequacy of the channel to pass the PMP, the flow depth and discharge velocity of each drainage channel, at the location where they discharge into the proposed detention/sedimentation pond, was determined by Manning's Equation for Uniform Flow (Equation 3). The flow depth was compared to the proposed channel depth (3 feet) to determine if the channel size was adequate. The discharge velocities for each condition were compared to the recommended maximum permissible velocities shown in Table 5.1 for channels. This information is presented in Table 7.1.

TABLE 7.1

CIRCUMFERENTIAL DRAINAGE CHANNELS FLOW CAPACITY

Assumed Channel Vegetative Condition	Assumed Disposal Cell Vegetative Condition	"C" Value (*)	Peak Flow Rate (cfs)	Flow Velocity (fps)	Flow Depth (feet)
East Perimeter Drainage Channel					
Uncut Weeds and Brush	Meadow	0.32	88.4	3.2	2.3
	Forest	0.17	42.4	2.7	1.8
Bare Earth	Meadow	0.32	88.4	6.0	1.7
	Forest	0.17	42.4	5.0	1.3
West Perimeter Drainage Channel					
Uncut Weeds and Brush	Meadow	0.32	93.0	3.3	2.4
	Forest	0.17	45.6	2.7	1.8
Bare Earth	Meadow	0.32	93.0	6.1	1.8
	Forest	0.17	45.6	5.1	1.3

(*) "C" value is based on Hydrologic Group B, Table 7-2, (McCuen, 1989)

The calculated circumferential drainage channel flow velocities, for uncut weeds and brush channel conditions, do not exceed the recommended maximum permissible velocity, (5 feet per second), presented in Table 5.1. The calculated circumferential drainage channel flow velocities, for bare earth channel conditions, exceeds the recommended maximum permissible velocity, (2.5 feet per second), presented in Table 5.1 for channels. The calculated flow depth of the perimeter drainage channels during the PMP does not exceed the proposed channel depth of three feet.

8.0 SLOPE STABILITY

The TAD discusses assessing the long-term stability of tailing piles under various loading conditions, including the influence of seismic conditions. Kerr-McGee (KMCC, 1986) evaluated static and dynamic (seismic) conditions, but did not evaluate the long term static condition with flood stability, typically called rapid drawdown. This condition assesses the slope assuming it is fully saturated, which may occur as a result of the PMP and resulting flood.

The factor-of-safety of the disposal cell sideslopes under full saturated conditions was calculated using Purdue University's, PC STABL 5M stability analysis program. This program was developed by the university as part of the Joint Highway Research Project, Indiana Department of Highways. The program computes factors-of-safety using the simplified Janbu, simplified Bishop, and Spencer methods (Achilleous, 1988). For the evaluation of the proposed disposal cell sideslopes, the simplified Bishop method was used.

To be consistent with the stability analysis previously performed by Kerr-McGee (KMCC, 1986), the soil parameters assumed by Kerr-McGee were utilized to analyze the sideslope under the full saturation condition. The total unit weight of the various soil types were provided by Kerr-McGee's analysis. Therefore, it was assumed that the saturated unit weight for each soil type was equal to the total unit weight assumed by Kerr-McGee (KMCC, 1986). This assumption is considered conservative and will result in a lower calculated factor-of-safety. The soil parameters assumed for the evaluation are presented in Table 8.1. NUS did not have access to the laboratory data prepared by Kerr-McGee. Therefore, NUS cannot assess the validity of the soil parameters presented in Table 8.1.

The soil parameters presented on Table 8.1 were obtained from the stability analysis performed by Kerr-McGee (KMCC, 1986). Evaluation of these parameters was considered beyond the scope of this assessment, and not the purpose of the evaluation.

TABLE 8.1

SOIL PARAMETERS FOR SLOPE STABILITY ANALYSIS

Soil Type	Total Unit Weight (pounds/ft^3)	Saturated Unit Weight (pounds/ft^3)	Cohesion Intercept (pounds/ft^2)	Effective Friction Angle
Foundation Soils (*)	135	135	35	33°
Topsoil	120	120	100	30°
Intrusion Barrier	135	135	0	34°
Select Fill	135	135	0	31°
Low Permeability Soil	135	135	0	31°
Sand and Gravel	135	135	0	34°
Waste	126	126	400	0°

(*) Average of s[illegible]undation soils identified in Table 4-6 (KMCC, 1986).

The factor-of-safety was calculated for the two typical landfill berm sections, as depicted on Figure 4. Table 8.2 presents a summary of the slope stability analysis performed.

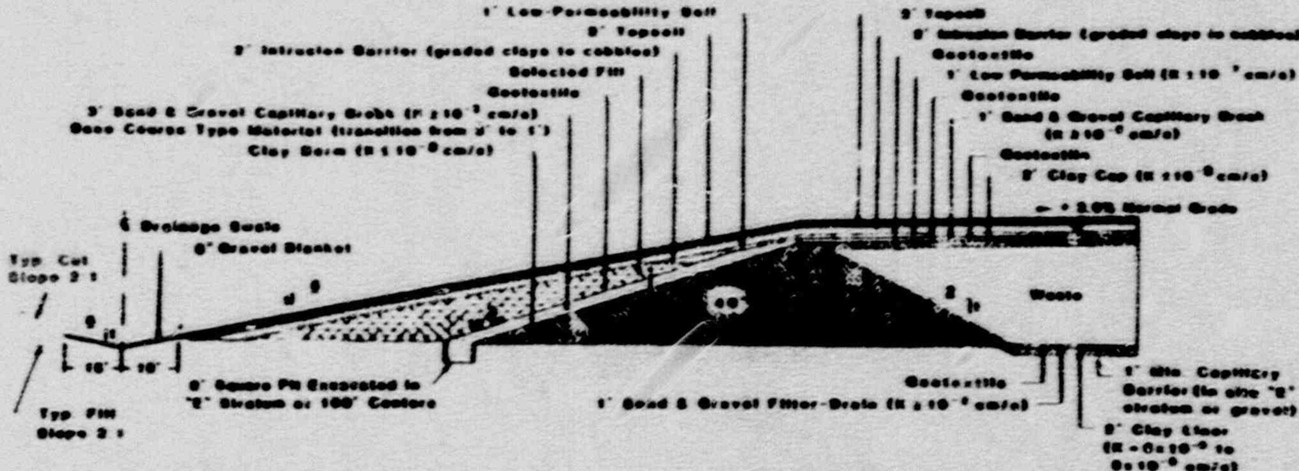
TABLE 8.2

SLOPE STABILITY ANALYSIS SUMMARY

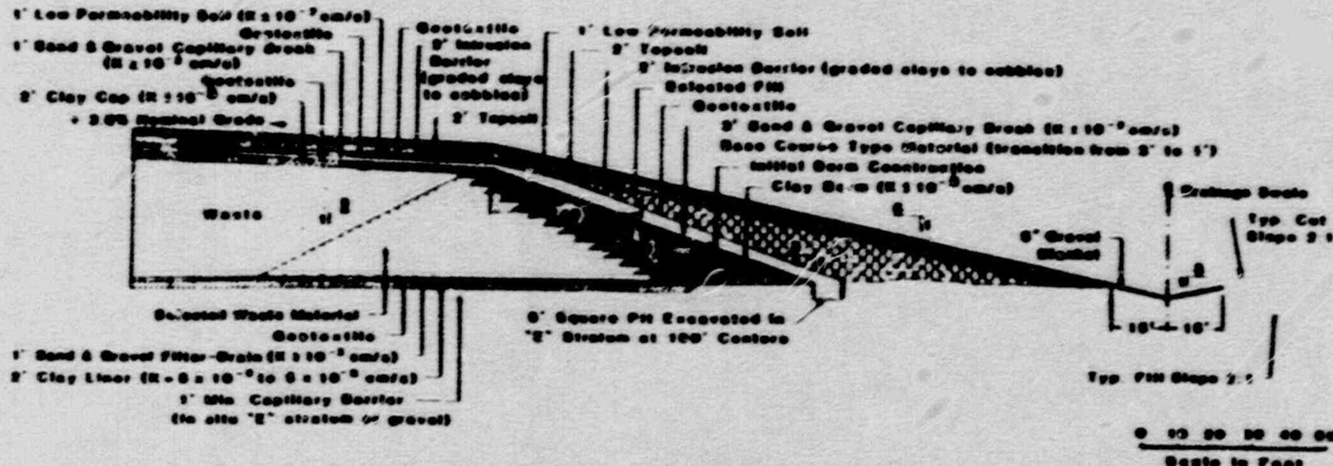
Design Condition	Factor-of-Safety	
	Computed	Required (*)
Full Saturation		
(North and East Sideslopes)	1.807	1.2
(South and West Sideslopes)	1.807	1.2

(*) (DOE, 1989)

Figures 5 and 6 depict the most critical failure surface for the berm sections evaluated. Based on the soil parameters assumed by Kerr-McGee, the computed factor-of-safety under full saturation condition exceeds the TAD's required factor-of-safety.



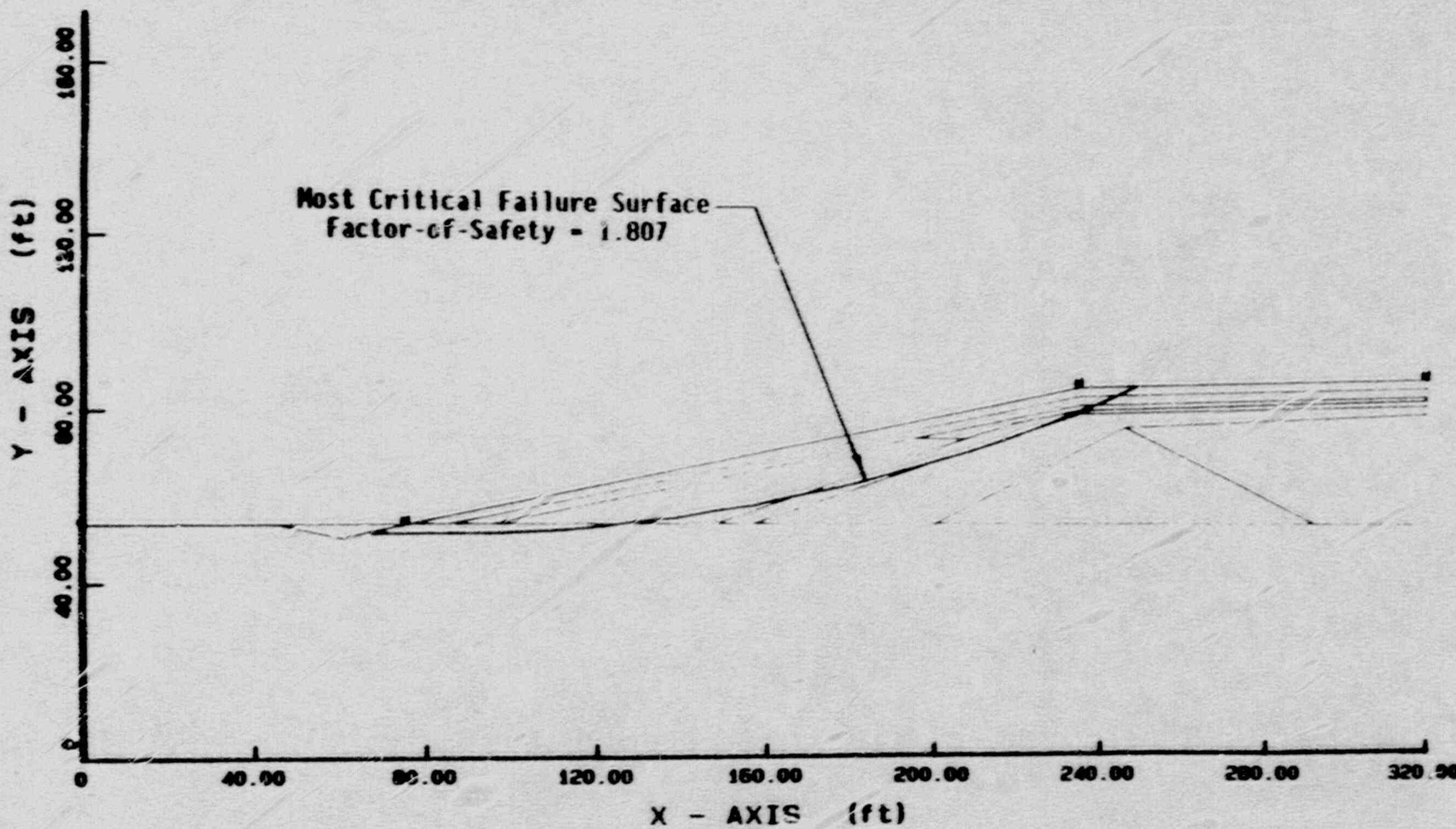
Typical Berm Section - South And West Sides



Typical Berm Section - North And East Sides

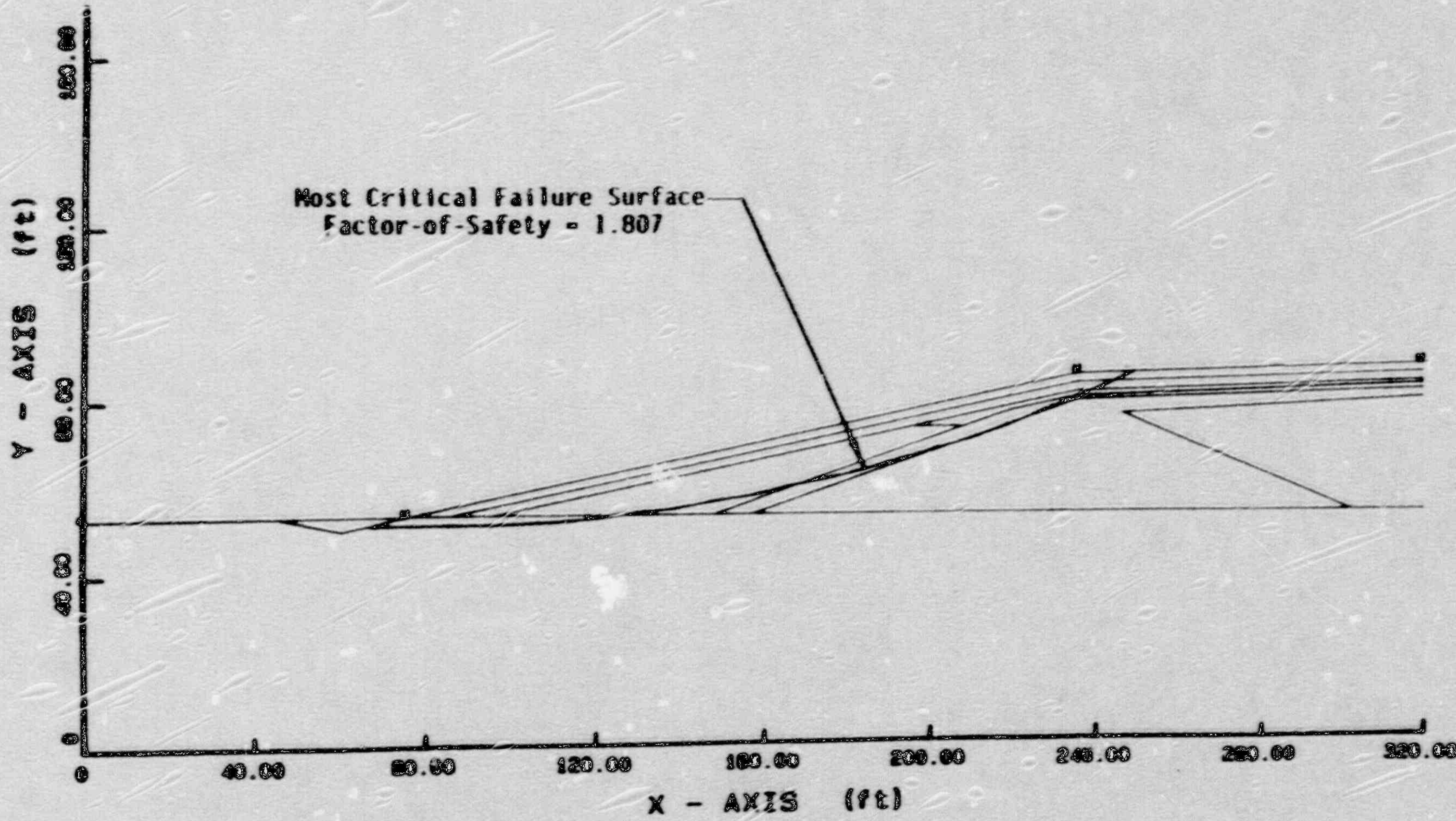
Source: Supplement to the Final Environmental Statement related to the decommissioning of the Rare Earths Facility, West Chicago, Illinois, 1989, (NRC, 1989).

Typical Landfill Berm Sections | **Figure 4.**



Most Critical Failure Surface - North and East Sideslopes

Figure 5.



Most Critical Failure Surface - South and West Sideslopes

Figure 6.

9.0 DETENTION/SEDIMENTATION POND SPILLWAY

Peak runoff rates from the disposal cell for tall grass prairie, and wooded (forest) cover conditions were calculated by the Rational Method to evaluate the capacity of the detention/sedimentation pond spillway to pass the PMP. The flow depth and discharge velocity across the proposed spillway were then determined by Exhibit 11-3.1 - Design Data for Earth Spillways, Soils Conservation Service - Engineering Field Manual (DOA, 1974).

Since the probability is low that the entire disposal cell would be bare during the PMP event, calculation of the peak runoff rate from the disposal cell assuming bare earth conditions across the entire disposal cell surface was not performed. Assumed vegetative conditions for the spillway were grass and bare earth for both tall grass prairie and wooded (forest) cover conditions. Had bare earth conditions been assumed across the entire disposal cell for the bare earth spillway evaluation, peak inflow rates to the spillway and spillway discharge velocities would have been greater than for the assumed disposal cell vegetative conditions.

Based on Figure B.1 (KMCC, 1986) the following design criteria were used to assess the spillway's capability to pass the PMP:

- Spillway width = 100 feet
- Vegetated Spillway
- Spillway Sideslopes = 3:1 (assumed)
- Pipe Spillway (none shown)

Table 9.1 summarizes the peak runoff rate from the disposal cell and the resulting flow depth and discharge velocity across the proposed spillway.

The calculated discharge velocity, for grass spillway conditions, does not exceed the recommended permissible velocity, (5 feet per second), presented in Table 5.1 for spillways. The calculated discharge velocity, for bare earth spillways, exceeds the recommended maximum permissible velocity, (2.5 feet per second), presented in Table 5.1 for spillways.

Figure B.1 (KMCC, 1986) indicates that the sideslope of the spillway will only be one foot high. Generally, one to two feet of freeboard is provided for a spillway of this type. With a maximum flow depth of approximately one foot, it is apparent that during the PMP it is possible that the

TABLE 9.1

DETENTION/SEDIMENTATION POND SPILLWAY VELOCITIES

Assumed Spillway Vegetative Condition	Assumed Disposal Cell Vegetative Condition	Peak Inflow Rate (cfs)	Spillway Flow Depth (feet)	Spillway Discharge Velocity (fps)
Grass	Meadow	210	1.0	4.0
	Forest	112	0.7	3.3
Bare Earth	Meadow	210	1.0	3.9
	Forest	112	0.8	3.5

detention/sedimentation pond may overflow. Therefore, it is recommended that one to two feet of additional freeboard be provided for the detention/ sedimentation pond.

10.0 SUMMARY

The following summarizes the results of the evaluation of the design of the proposed Kerr-McGee Chemical Corporation Rare Earths Facility disposal cell for resistance to erosion for the Probable Maximum Precipitation (PMP) event. The evaluation included calculating the velocity of runoff for overland "sheet" flow and shallow concentrated flow on the proposed landfill surface, calculating the velocity and flow depth in the proposed perimeter drainage channels and detention/ sedimentation pond spillway for the PMP event. The factor-of-safety of the cover system assuming full saturation of the cap material was also calculated.

The PMP storm duration and magnitude was the 1-hour, 1-square mile PMP (17.5 inches), as determined from the National Oceanic and Atmospheric Administration (NOAA) Hydrometeorological Report No. 52 (DOC, 1982). Incremental rainfall duration percentages of the 1-hour, 1-square mile PMP storm were used to determine the peak runoff rate, based on the time-of-concentration for each representative drainage area, for each criterion evaluated.

Vegetative cover conditions proposed for the disposal cell were tall grass prairie, wooded (forest) and bare earth conditions. Maximum permissible velocities for these exact conditions were not available in the referenced literature. In addition, maximum permissible velocities for different vegetative cover conditions vary based on the source of reference. For this evaluation, maximum permissible velocities, based on vegetative cover conditions and landfill slope, were obtained from two sources, EPA, 1985, and Chow, 1959. The recommended maximum permissible velocity of 5 feet per second, the maximum recommended where good covers and proper maintenance cannot be guaranteed (Chow, 1959), were used for comparison with the calculated velocities for each criterion evaluated.

Sheet flow velocities, based on a calculated time-of-concentration, were determined by a method presented in the Uranium Mill Tailings Remedial Action Project's Technical Approach Document (TAD), (DOE, 1989). The following two methods were utilized to estimate shallow concentrated flow velocities:

- Average Shallow Concentrated Flow Velocity Method (Figure 3)
- Uniform Surface Flow Method (The Rational Method and Manning's Equation for Uniform Flow)

For the circumferential drainage channels, the flow velocity and flow depth were calculated by the Rational Method and Manning's Equation for Uniform Flow; Equations 2 and 3, respectively. The flow depth and discharge velocity across the detention/sedimentation pond spillway was calculated by a method presented in the Soil Conservation Service - Engineering Field Manual (DOA, 1974).

Table 10.1 summarizes the results of the evaluation for resistance to erosion for the PMP event. The table identifies the calculated velocities and the recommended maximum permissible velocity for each runoff condition evaluated. As indicated in Table 10.1, flow velocities for bare earth conditions, (which may occur as a result of fire, drought, or disease), exceed the recommended permissible velocity of 2.5 feet per second for all conditions evaluated, with the exception of the average shallow concentrated flow velocity. For tall grass prairie and wooded (forest) conditions, calculated flow velocities are below the recommended maximum permissible velocity of 5 feet per second for all conditions evaluated, as indicated in Table 10.1.

The factor-of-safety of the disposal cell sideslopes was calculated for the two typical landfill berm sections depicted on Figure 4. The analysis was performed using, PC STABL 5M, Purdue University's stability analysis program which employs the simplified Bishop Method under full saturation conditions. To provide consistency, soil parameters assumed by Kerr-McGee in their slope stability analysis were used. The minimum factor-of-safety calculated for both berm sections (F.S. = 1.807) was found to exceed the minimum requirement outlined in the TAD (F.S. = 1.2).

TABLE 10.1
SUMMARY OF RUNOFF VELOCITIES FOR THE PMP

Runoff Condition	Slope	Assumed Disposal Cell Vegetative Condition	Flow Depth (feet)	Flow Velocity (fps)	Recommended Maximum Permissible Velocity (*)
Sheet Flow	Cap (3% slope)	Turf	n/a	2.0	5 fps
		Bare Earth	n/a	8.3	2.5 fps
	Sideslopes (5:1 slope)	Turf	n/a	4.9	5 fps
		Bare Earth	n/a	16.7	2.5 fps
Shallow Concentrated Flow					
Avg. Flow Velocity	Cap (3% slope)	Short Grained Pasture	n/a	1.2	5 fps
		Woodland	n/a	0.85	5 fps
		Nearby Bare and Untilled	n/a	1.8	2.5 fps
	Sideslopes (5:1 slope)	Short Grained Pasture	n/a	3.1	5 fps
		Woodland	n/a	2.2	5 fps
		Nearby Bare and Untilled	n/a	4.6	2.5 fps
Uniform Flow Velocity	Sideslopes (5:1 slope)	High Grass	0.11	4.4	5 fps
		Timber	0.13	1.8	5 fps
		Bare Earth	0.10	6.5	2.5 fps
Circumferential Drainage Channels					
East Perimeter Channel - Uncut Weeds and Brush		Meadow	2.3	3.2	5 fps
		Forest	1.8	2.7	5 fps
West Perimeter Channel - Uncut Weeds and Brush		Meadow	2.4	3.3	5 fps
		Forest	1.8	2.7	5 fps
East Perimeter Channel - Bare Earth		Meadow	1.7	6.0	2.5 fps
		Forest	1.3	5.0	2.5 fps
West Perimeter Channel - Bare Earth		Meadow	1.8	6.1	2.5 fps
		Forest	1.3	5.1	2.5 fps
Detention/ Sedimentation Pond Spillway - Grass		Meadow	1.0	4.0	5 fps
		Forest	0.7	3.3	5 fps
Detention/ Sedimentation Pond Spillway - Bare Earth		Meadow	1.0	3.9	2.5 fps
		Forest	0.8	3.5	2.5 fps

(*) The permissible velocities apply to average, uniform stands of grass cover. Permissible velocities exceeding 5 feet per second should only be used where good covers and proper maintenance can be obtained. (Chow, 1959)

All calculations were based on sound engineering judgment and standard engineering practice. Variations either up or down, in the values calculated will result if different assumptions for runoff coefficients are used. Therefore, due to the inherent nature of hydrologic analysis, the calculated velocities should be used as an indicator to determine if the potential for erosion of the proposed disposal cell exists.

11.0 REFERENCES

Achilleos, E., 1988. User Guide for PC STABL 5M, Purdue University, West Lafayette, Indiana.

Chow, V.T., 1959. Open Channel Hydraulics, McGraw Hill Book Company, Inc., New York, New York.

Kerr-McGee Chemical Corporation (KMCC), 1986. West Chicago Project Engineering Report, Volume IV - Cell Engineering. (NUS only had access to pp. 4-10 to 4-15.)

McCuen, R.H., 1989. Hydrologic Analysis and Design, Prentice Hall, Englewood Cliff, New Jersey.

Oosting, H.J., 1956. The Study of Plant Communities, W.H. Freeman and Company, San Fransico, California.

U.S. Department of Agriculture (DOA), 1974. Engineering Field Manual, Soil Conservation Service.

U.S. Department of Agriculture (DOA), 1986. Urban Hydrology for Small Watersheds, Technical Release 55, Soil Conservation Service.

U.S. Department of Commerce (DOC), 1977. NOAA Hydrometeorological Report No. 49, Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages, National Oceanic and Atmospheric Administration.

U.S. Department of Commerce (DOC), 1982. NOAA Hydrometeorological Report No. 52, Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian, National Oceanic and Atmospheric Administration.

U.S. Department of Energy (DOE), 1989. Technical Approach Document, Revision II, Uranium Mill Tailings Remedial Action Project.

U.S. Department of the Interior (DOI), 1977. Design of Small Dams, Bureau of Reclamation.

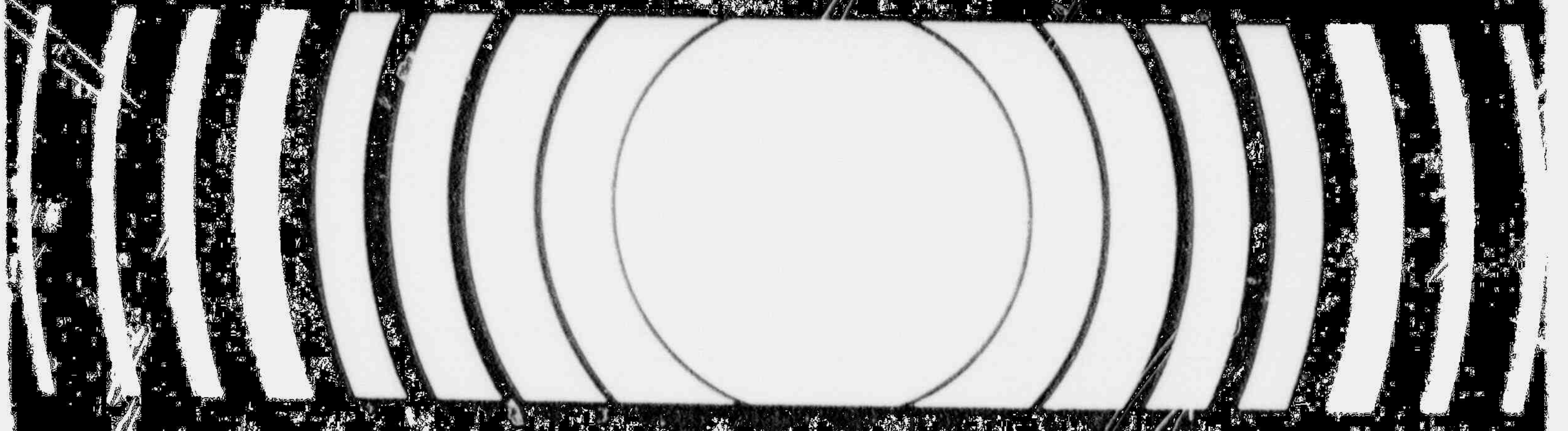
U.S. Environmental Protection Agency (EPA), 1985. Covers for Uncontrolled Hazardous Waste Sites, Hazardous Waste Engineering Research Laboratory, Office of Research and Development, Cincinnati, Ohio.

U.S. Nuclear Regulatory Commission (NRC), 1989. Supplement to the Final Environmental Statement related to the decommissioning of the Rare Earths Facility, West Chicago, Illinois.

EPA

Final Environmental Impact Statement for Standards for the Control of Byproduct Materials from Uranium Ore Processing (40 CFR 192)

Volume I



United States
Environmental Protection
Agency

Office of
Radiation Programs
Washington, DC 20460

September 1983
EPA 520/1-83-008-1

Radiation

EPA

Final Environmental Impact Statement for Standards for the Control of Byproduct Materials from Uranium Ore Processing (40 CFR 192)

Volume I

changes in priorities, or through the failure of special funding mechanisms.

8.2.1 Human Intrusion

The effectiveness of controls in discouraging intrusion over long time periods is difficult to evaluate. Probably the worst scenario is the use of tailings as a resource for construction material by residents of a nearby population center. This can (and has) led to widespread use of tailings around, under, and in residences, schools, and other inhabited structures. Easily removable or attractive control materials may have a potential for promoting misuse. Examples are fences and easily removed rock covers.

Inhibiting of intrusion for long periods is more likely to be successful by using passive methods. Thick earth covers, for example, provide significant long-term passive protection against intrusion. Other effective "passive" methods include heavy rock cover, deep-mine disposal, below-grade disposal, solidification in a cement or asphalt mixture, or coverings of a tailings-cement mix.

8.2.2 Erosion and Gully Intrusion

All surface disposal methods are subject to erosion. Erosion of stabilized tailings piles can occur as or be caused by sheet erosion, gully intrusion or erosion, wind erosion, and differential settlement. Nelson et al. (Ne83) describe these various modes and discuss long-term mitigating measures in some detail.

Sheet erosion is caused by unconcentrated water flowing directly over the surface of the tailings impoundment and the cover (the engineering design methods necessary to control such erosive forces). Sheet erosion is defined as that erosion which occurs as a result of the impact of raindrops striking the ground surface or water flowing in small ephermal rills. The amount of sheet erosion that can occur at a given location depends on the slope of the land, nature of the cover material, type and density of the cover material, and rainfall duration and intensity.

Control of sheet erosion can be accomplished by grading the cover to gentle, flat slopes and placing gravel, cobbles, or rock layers over the cover, or coarse gravel mixed with finer soil. Such controls can be considered to duplicate desert landforms that have been stable for thousands of years and are described as desert pavements or gravel armor. The design of such controls is quite site specific, however, as emphasized by Nelson, et al. (Ne83).

Gully erosion is caused by concentrated water flowing over the tailings that can cut deep channels through embankments or cover materials and disperse tailings downstream. Gullies can also be initiated off the tailings area and migrate upstream into the tailings. The formation of gullies depends on topographical features, such as slope angle and slope length, the existence of stable base levels on or near the site, erodibility of the soil, and the flood flow velocity.

The best method of controlling gully erosion is by preventing gully initiation (Ne83). Topographical features can be altered by providing gentle and shorter slopes, gradual changes in grade, and establishing base levels around the site (rock trenches, wing walls, etc.). Soil erodibility can be reduced by providing larger grained soils (gravel) and/or natural vegetation. Flood flow velocity can be reduced or eliminated by providing diversion ditches. Gentle and short slopes can also reduce this velocity. Depending on a given site's features, it is likely a combination of these controls will be required.

Wind erosion is caused by suspension of small particles in the air and by creep of particles moving along the ground surface. Materials most highly susceptible to wind erosion are fine-grained noncohesive sands and silts with diameters in the range of 0.02 to 0.10 mm. Particles less than 0.002 mm, which are classified as clays, are highly resistant to wind erosion due to cohesion (Ne83).

Wind erosion may be controlled by increasing surface roughness through vegetation and using different rock sizes. Measures taken to control water sheet erosion generally should minimize losses by wind erosion.

Differential settlement is not erosion itself but can initiate erosion by channelizing runoff. It can also cause failures by cracking of cover material and by impounding water in depressions. Factors which cause differential settlement include differences in compressibility between different grain sizes of tailings, nonuniformity of tailings in the impoundment, and variation in compressibility of underlying materials.

Controls for differential settlement are surcharging and grading. In surcharging, more cover material than necessary is placed over compressible materials to cause a known amount of settlement within the material. Grading also places additional cover over compressible materials, where differential settlement is not expected to be great.

8.2.3 Floods and Other Natural Processes

Natural processes that can destroy the integrity of disposed tailings piles include floods, winds, and earthquakes. Floods are probably the greatest hazard to integrity. Methods are available to protect piles against floods. New piles can be located so as to minimize disruptions from floods and winds. For existing and new piles, diversion ditches and embankments can be constructed, rocks can be placed on the slopes of piles (and on top, if needed), and the tailings can be graded to gradual slopes. Existing piles can also be moved, if sufficient protection is not afforded by these methods. These are all passive controls.

The time over which controls should be effective is an important factor in standards for long-term protection. Specifying this time directs the design of disposal methods that have reasonable assurance of providing such effectiveness over this period. The design of a tailings disposal method is similar to the design of other major projects, such as dams, bridges, causeways, etc., that are subjected to natural disruptive processes (Ju63, Ne63, Cob78).

The first design step is to determine the size of the flood that will be used in the design of the disposal method. This is accomplished by a probabilistic analysis. For example, a flood of a certain magnitude will occur periodically, i.e., a 100-year flood is defined as a flood that has a recurrence rate of 1/100 each year, or 0.01 in any one year.

The probability (or likelihood) that a flood equal to or greater than this 100-year flood will occur in a specified number of years is given by the formula:

$$P_t = 1 - (1-t)^n$$

where

P_t = Probability that an event with recurrence rate of t will occur in n years.

t = Recurrence rate of an event (1/T)

T = Recurrence time of event in years

n = Period of concern in years.

The probability that a 100-year event (flood) will occur sometime during a 100-year period is thus 0.63, as is the probability that a 1,000-year event (flood) will occur sometime during a 1,000 year period. Thus, it is more likely than not that an event with a recurrence time equal to the period of concern will occur within the period of concern.

For any period of concern, it is useful to determine a series of probabilities that events with various recurrence times will occur within that period of concern. For example, probabilities and corresponding recurrence times are plotted in Figure 8-1 for three periods of concern; 100 years, 400 years, and 1,000 years. This plot

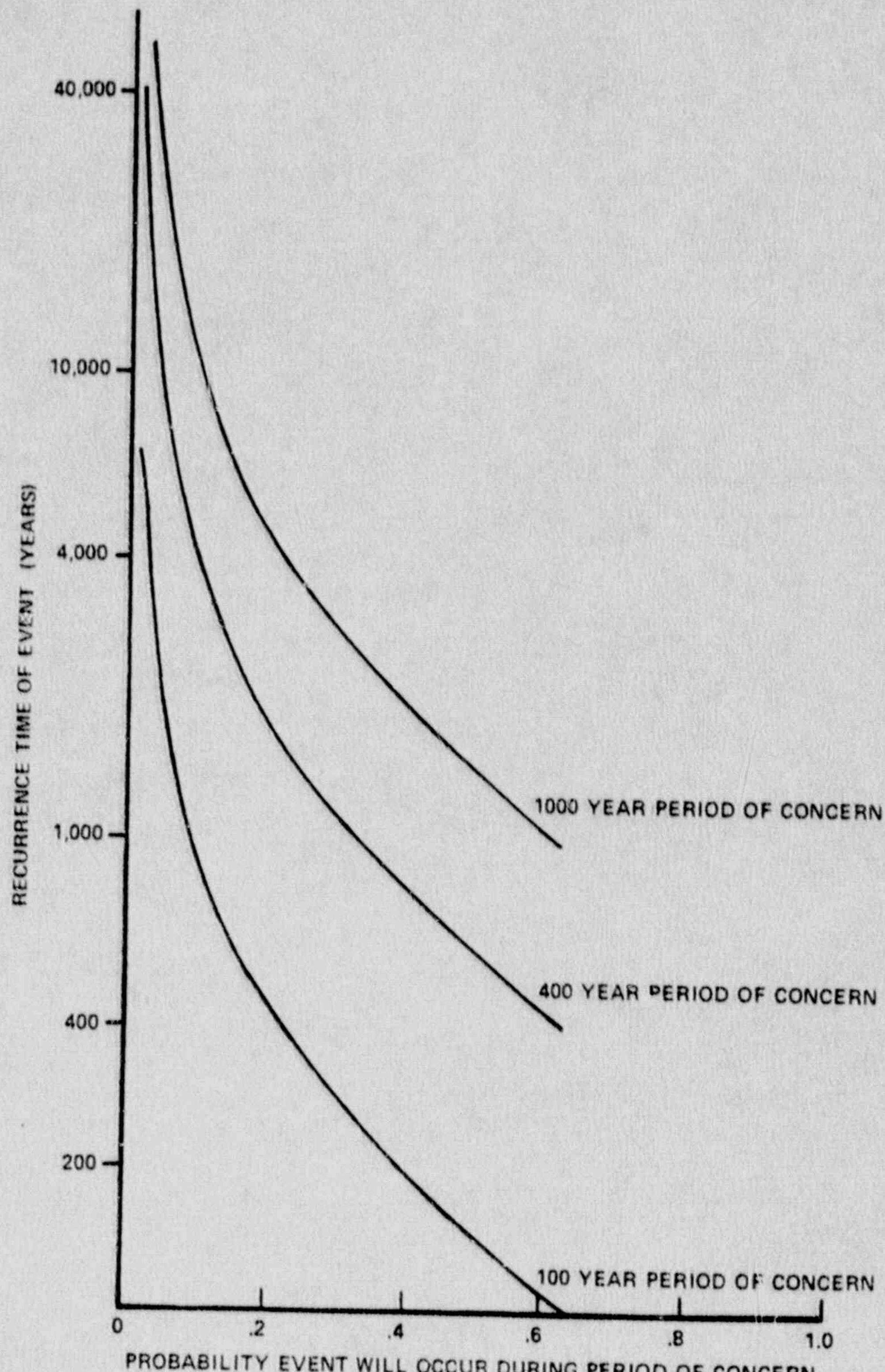


Figure 8-1. Recurrence Times Versus Probabilities for Various Periods of Concern.

clearly illustrates that the probability is high that an event with a recurrence time equal to the period of concern will occur during the period of concern, as noted above.

The most important point shown in Figure 8-1, however, is that the recurrence time becomes very long for low probabilities, regardless of the period of concern. (The recurrence time defines the size, or design, of the event (flood), i.e., a recurrence time of a 10,000-year flood). For example, for a probability of 5 percent the design event is 2000 years for a 100-year period of concern, is almost 10,000 years for a 400-year period of concern, and is 20,000 years for a 1,000-year period of concern. Thus, specifying the period of concern (or the period over which protection must be provided) determines the size of the event (flood) for design purposes, given some reasonably low probability that the event will occur within the period of concern.

The long recurrence times of these design floods preclude the use of historical data, which are of too short a duration. Rather the design is based on the probable maximum flood (PMF) which in turn is determined from the probable maximum precipitation (PMP) over the area that could affect the disposed tailings. The PMP can be obtained from depth-area-duration relationships developed for the entire United States by the National Oceanographic and Atmospheric Administration (NOAA60, NOAA77-78). It is important to recognize that the size of flood, is not proportioned, in general, to the length of the period of concern. That is, in most cases the PMF is not significantly larger than projections of floods for only moderately long periods of concern (e.g., 1,000-year floods). Nelson, et al. (Ne83) discuss this in detail, especially in regard to size of the drainage basin contributing to the PMF at specific sites. They conclude, "To provide for a level of risk consistent with normal engineering practice for 200-, 500-, or 1,000-year stability periods requires a design storm having a recurrence interval of several thousand years. Because the PMP is based on site specific physical meteorological limitations which avoid the inaccuracies associated with extending limited data bases for long time periods, it is reasonable and prudent to use a PMF based on the PMP as the design flood."

8.2.4 Longevity of Control

We have chosen two time periods for evaluating the longevity of effective control. A short time period of 100 years was chosen for one case, since this has been proposed as the limit for reliance on institutional controls (EPA78). A period of about 1,000 years was selected for the second case. This case displays the difference between active and passive controls, as well as the expected variation of effectiveness of controls over longer time periods.

In general, the effectiveness of controls over time can be rated as follows:

Highest - Deep geological disposal.

- Below-grade surface disposal.

- Above-grade surface disposal, entire area covered with thick earth and rock cover.

- Above-grade surface dispoal, entire area covered with thick earth, slopes covered with rock.

- Above-grade surface disposal, entire area covered with thick earth.

Lowest - Above-grade surface disposal, entire area covered with thin earth and maintained.

This ranking assumes the tailings pile is located where erosion occurs. If tailings are located where soil deposition is taking place, the ranking will be equal for all cases as long as deposition continues.

8.3 Disposal Methods and Effectiveness

8.3.1 Earth Covers

Earth placed over tailings slows the movement of radon into the atmosphere by various attenuation processes. When the earth is moist, attenuation increases. Different soils have different attenuation properties; these can be approximately quantified in terms of a quantity called the "half-value layer" (HVL). The HVL is that thickness of cover material (soil) that reduces radon emission to one-half its value. Figure 8-2 shows the percentage of radon that would be predicted to penetrate various thicknesses of materials with different HVLs. These values are nominal; the actual HVL may vary significantly. From Figure 8-2 it can be seen that 3 meters of sandy soil (HVL = 1.0 meters) is projected to reduce the radon released from tailings by about 90 percent. Soils with better attenuation properties would require less thickness to achieve the same reduction. For example, 1 meter of compacted moist soil (HVL = 0.3 meters) would be predicted to reduce the radon release by about 90 percent.

A more complete treatment of radon attenuation based on the work of Rogers (Ro81), is given in Appendix P of the NRC Generic EIS for mill tailings. That analysis concludes that the effectiveness of an earthen cover as a barrier to radon depends most strongly on its moisture content. Typical clay soils in the uranium milling regions of western United States exhibit ambient moisture contents of 9 percent to 12 percent. For nonclay soils, ambient moisture contents range from 6 percent to 10 percent. The following table provides, as an example, the cover thicknesses needed to reduce the radon emission to 20 pCi/m^2s for the above ranges of soil moisture. Four examples of tailings are

COPY

AFFIDAVIT OF JAMES BENETTI

1. My name is James Benetti. I am employed by the United States Environmental Protection Agency as a Health Physicist. I am authorized by the Regional Administrator, USEPA Region V, to give this affidavit. I am authorized by the Director of the Office of Radiation Programs, USEPA, to give the interpretations contained in this affidavit on behalf of the USEPA.

2. I hold a Bachelor's Degree in Physics from the University of Michigan, and a Master's Degree in Physics from the University of Wisconsin. I have worked for the USEPA for two years in the capacity of Health Physicist. I have worked for the United States Department of Energy for eight months in the capacity of Health Physicist. I have worked for the State of Wisconsin, Section of Radiation Protection for five years in the capacity of Health Physicist.

3. I have reviewed Table 5.11 of the Supplement to the Final Environmental Statement related to the decommissioning of the Rare Earths Facility, West Chicago, Illinois (NUREG-0904, Supplement No. 1, Vol. 1).

4. Said Table 5.11 indicates that annual dose equivalents instead of total 50 year dose equivalents were calculated for doses to the bone, lung and bronchial epithelium of the maximally exposed individual. When I requested clarification as to how these calculations were performed, I was informed by Mr. Yuchien Yuan of Argonne National Laboratory, verbally at an official meeting between NRC staff and USEPA on June 30, 1989, and in subsequent written communication, that these doses represented the first year contribution from intakes of radionuclides incurred during the year for which the doses were estimated.

5. Such a method of computation is improper for the purpose of comparison with USEPA's Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings contained at Title 40 of the Code of Federal Regulations, Part 192.41 (d), because it fails to account for the increments to annual organ dose equivalent which are due to intakes of radionuclides retained in the body from previous years of exposure to facility operations. This issue was stated to USNRC staff in correspondence from my agency dated July 27, 1989, and, to this date, has not been satisfactorily resolved.

6. The USEPA interprets that the "annual dose equivalent" to any organ, (excepting the thyroid) which is specified in 40CFR 192.41 (d), and limited to the value stated, means the dose equivalent delivered in that year as a result of all intakes up to and including that year, attributable to the operations of the facility. Such contributions to organ dose equivalent, due to retained radionuclides are to be calculated back to the effective date of the standard, namely December 6, 1983. Alternatively, the computation of 50 year committed organ dose equivalents would be acceptable, since they are more conservative and easier to compute.

7. Since the maximally exposed individual for which dose is estimated in Table 5.11 will have been exposed continuously to radiation from facility operations and decommissioning prior to commencement of the action period, and will be exposed to additional radiation for an estimated seven years from the beginning of the proposed action period it is USEPA's position that the annual organ dose equivalents for bone and lung which appear in Table 5.11 must include the contributions of past years' intakes starting from December 6, 1983, and continuing through the last year of the action period, for purposes of demonstrating compliance with USEPA's standards.

Further Affiant sayeth naught.

/s/ FEB 22 1990

--------------------- Date -------

James C. Benetti

Signed and sworn before me this ---- day of ------------, 19--

/s/

Notary Public

ORC

TJW 2/22/90

DOCKETED
USNRC

'90 MAY 22 P3:31

OFFICE OF SECRETARY
DOCKETING & SERVICE
BRANCH

CERTIFICATE OF SERVICE

I hereby certify that, as approved in discussions with the Secretary of the Atomic Safety Licensing Appeal Board and the Secretary of the Nuclear Regulatory Commission, I have caused a copy of the foregoing Amicus Curiae Brief of the United States Environmental Protection Agency to be transmitted by electronic telefacsimile to the Secretaries of the ASLAB and the NRC, the original to be mailed by overnight courier to the Secretary of the ASLAB, and true and accurate copies of it to be mailed by overnight courier to the Secretary of the NRC and:

Peter J. Nickles
Richard A. Meserve
Herbert Estreicher
Covington and Burling
1201 Pennsylvania Avenue, N.W.
Washington, D.C. 20044

Douglas J. Rathe
Assistant Attorney General
Environmental Control Division
100 W. Randolph Street, 12th Floor
Chicago, IL 60601

Joseph V. Karaganis
James D. Brusslan
Karaganis & White, Ltd.
414 North Orleans Street, Suite 810
Chicago, IL 60610

I have also caused copies of the EPA's amicus curiae brief to be mailed by First Class mail to the other addressees on the service list.

Marc M. Radell

Marc M. Radell
Assistant Regional Counsel

Dated this 21st day of May, 1990.