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MEMORANDUM FOR: Leo B. Higginbotham, WMLU
Division of Waste Management

FROM: Malcolm R. Knapp, WMGT
Division of Waste Management

COMMENTS: DRAFT STANDARD REVIEW PLAN FOR GEOLOGIC-SEISMOLOGIC REVIEWS OF UMTRAP DOCUMENTS

Pursuant to Technical Assistance Request TAR-85023, we are pleased to submit to you a draft of the Standard Review Plan (SRP) for Geologic-Seismologic Reviews of UMTRA Documents (i.e., Remedial Action Plans). This SRP was prepared and coordinated by Jose Valdes (geology) with support from Michael Blackford (seismology).

The draft SRP contains separate sections on the statutory basis for the geologic and seismologic reviews of RAP's that we consider to be an integral part of the justification of the roles of these disciplines in the UMTRAP review process. If, as you have indicated, WMLU plans to merge this SRP with that of WMEG, retention of these separate sections might need to be discussed prior to the next iteration. In that case, we would want to incorporate these sections into the appropriate technical sections of the revised document.

WMGT would like to emphasize that the present version of this SRP is intended to be a working draft, as the document has not undergone peer review beyond the branch. Aspects of the seismic hazard analysis review plan have been recently developed by Mr. Blackford and we are seeking peer review from seismologists in NRC and in our contractor pool. We look forward to receiving your comments on this draft. If you have any questions about the SRP, please contact Philip Justus.

Original Signed By

Malcolm R. Knapp, Chief
Geotechnical Branch
Division of Waste Management

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DRAFT STANDARD REVIEW PLAN
FOR GEOLOGIC AND SEISMOLOGIC REVIEWS
OF UMTRAP DOCUMENTS

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DRAFT STANDARD REVIEW PLAN FOR GEOLOGIC AND SEISMOLOGIC REVIEWS OF UMTRAP DOCUMENTS

1. UMTRCA DOCUMENTS (Remedial Action Plans)

1.1. Statutory Basis for Reviews

1.1.1 Uranium Mill Tailings Radiation Control Act of 1978 as Amended (UMTRCA), PL 95-604

Title I of the Uranium Mill Tailings Radiation Control Act of 1978 as amended (UMTRCA), provides the regulatory framework for the Uranium Mill Tailings Remedial Action Project (UMTRAP). Under UMTRCA, Congress authorized a program of assessment and remedial action at designated inactive uranium mill tailings sites to stabilize and control such tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public. Remedial actions, which are proposed in the form of Remedial Action Plans (RAP's), are to be selected and performed by the Department of Energy (DOE) with the concurrence of the Nuclear Regulatory Commission (NRC) and in accordance with the standards prescribed by the Environmental Protection Agency (EPA) [Sec. 108]. The DOE's authority to perform remedial actions under UMTRCA terminates 7 years after promulgation of the EPA standards unless Congress grants an extension [Sec. 112]. As the EPA standards became effective on March 7, 1983, this means that the UMTRA Project is to be completed by 1990.

The Act requires that, upon completion of remedial actions at a given site, the DOE maintain institutional control of the property in accordance to a license issued by the NRC [Sec. 104(f)(2)]. The NRC may require in its license that the DOE undertake a program of monitoring, maintenance, and emergency measures as necessary to protect public health and safety.

UMTRCA also addresses the matter of post-remediation disruption of tailings piles for purposes of natural resources recovery during the period of institutional control. Section 104(h) states that:

> "No provision of any [DOE-State cooperative] agreement under section 103 shall prohibit the Secretary of the Interior, with the concurrence of the Secretary of Energy and the [Nuclear Regulatory] Commission, from disposing of any subsurface mineral rights by sale or lease... which are associated with land on which residual radioactive materials

are disposed and which are transferred to the United States as required under this section if the Secretary of the Interior takes such action as the Commission deems necessary pursuant to a license issued by the Commission to assure that the residual materials will not be disturbed by reason of any activity carried on following such disposition. If any such materials are disturbed by any such activity, the Secretary of the Interior shall insure, prior to the disposition of the minerals, that such materials will be restored to a safe and environmentally sound condition as determined by the Commission...."

Other parts of UMTRCA deal with legal and financial considerations for the remedial action programs which are not directly relevant to this document.

1.1.2 40 CFR 192 Standards for Remedial Actions at Inactive Uranium Processing Sites

1.1.2.1 Subpart A--Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites

1.1.2.1.1 Applicability

As mandated by Section 108 of UMTRCA, amending Section 275 of the Atomic Energy Act, EPA promulgated standards applicable to the control of residual radioactive material associated with designated Title I sites and to subsequent restoration of such sites following any use of subsurface minerals under Section 104(h) of the Act. Control, as used in the current context, is defined as "any remedial action intended to stabilize, inhibit future misuse of, or reduce emissions or effluents from residual radioactive materials."

1.1.2.1.2 Standards

"Control shall be designed to:

(a) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

   (1) Exceed an average release rate of 20 picocuries per square meter per second [over the entire surface of the disposal site and over at least a one year period], or

(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.

1.1.2.2 Rationale and Implementation Guidelines

Though 40 CFR 192 does not provide any prescription of how the Subpart A standards should be implemented, generalized guidelines for their implementation are presented in Subpart C and, along with the bases and rationale for the standards, in the "Supplementary Information" sections. An derstanding of this collateral information is critical, as EPA states in ection IV(A) that: "It is our objective that implementation of these standards be consistent with the assumptions we made in deriving them."

The excerpts presented below have relevance in determining the scope of geologic-seismologic reviews of UMTRCA documents.

1.1.2.2.1 Supplementary Information Sections

Section II(B)(1), Cleanup and Control of Tailings

"The objective of tailings control and stabilization efforts are to prevent their misuse by man, to reduce radon emissions (and gamma radiation exposures), and to avoid the contamination of land and water by preventing erosion by natural processes. The longevity (i.e., long-term integrity) of control is particularly important. This is affected by the potential for disruption by man; by the probability of occurrence of such natural phenomena as earthquakes, floods, windstorms, and glaciers; and by chemical and mechanical processes in the piles." [Emphasis added.]

"If necessary, erosion can be inhibited by...moving them away from a particularly flood-prone or otherwise geologically unstable site." [Emphasis added.]

Section III(A)(3), Cost-Benefit Analysis

"The major hazard, the extent of possible future misuse of tailings by man, is almost impossible to quantify." [Emphasis added.]

"Under this standard most of the 24 tailings pile will be stable against erosion and casual intrusion for misuse for much longer than 1000 years." [Emphasis added.]

Section III(B)(1), Longevity of the Control

"We consider the single most important goal of control to be effective isolation and stabilization of tailings for as long a period of time as is reasonably feasible because tailings will remain hazardous for hundreds of thousands of years. The longevity of tailings control is governed chiefly by the possibility of intrusion by man and erosion by natural forces. Reasonable assurance of avoiding casual intrusion [for misuse] by man can be provided through the use of relatively thick and/or difficult-to-penetrate covers (such as soil, rock, or soil-cement). No standard can guarantee absolute protection against the urposeful works of man and these standards do not require such protection. [Emphasis added.]

Section IV(A) Guidance for Implementation

"The standard for control and stabilization of tailings piles is primarily intended as a design standard. Implementation will require a judgement that the method chosen provides a reasonable expectation that the provisions of the standard will be met . . . . This judgement will necessarily be based on site-specific analyses of the properties of the sites, candidate control systems, and the potential effects of natural processes over time, and, therefore, the measures required to satisfy the standard will vary from site to site." [Emphasis added.]

"We have concluded that primary reliance on passive measures is preferable, since their long-term performance can be projected with more assurance than that of measures which rely on institutions and continued expenditures for active maintenance." [Emphasis added.]

"As long as the Federal Government exercises its ownership right and other authorities [under UMTRCA] regarding these sites, they should not be systematically exploited by people or severely degraded by natural forces. We believe that these institutional provisions are essential to support any project whose objectives is as long term as are these disposal operations, and for which we have little experience. This does not mean that we believe primary reliance should be placed on institutional controls; rather, that institutional oversight is an essential backup to passive controls." [Emphasis added.]

Section III(B)(2) The Radon Release Limit

"We believe that limiting radon emissions from tailings piles serves several necessary functions: reducing the risk to nearby individuals and individuals at greater distances; and furthering the goals of reliable long-term deterrence

of misuse of tailings by man and control of erosion of piles by natural processes. The degree of reduction of radon emissions achieved by a disposal system is more or less directly related to the degree of abatement of each of these hazards." [Emphasis added.]

"Congress did not intend that EPA set standards for one generation only, or that it set standards without consideration of the long-term reliability of whatever means are available for implementing them. [Emphasis added.]

1.2.2.2 Subpart C, Guidance for Implementation

"The implementing agencies [including the NRC] shall establish methods and procedures to provide 'reasonable assurance' that the provision of Subpart A . . . are satisfied. This should be done as appropriate through the use of analytic models and site-specific analyses . . . ." [Emphasis added.]

"The purpose of Subpart A is to provide for long-term stabilization and isolation in order to inhibit misuse and spreading of residual radioactive materials, control releases of radon to air, and protect water. Subpart A may be implemented through analysis of the physical properties of the site and the control system and projection of the effects of natural processes over time. Events and processes that could significantly affect the average radon release rate from the entire disposal site should be considered. . . . Computational models, theories, and prevalent expert judgement may be used to decide that a control system design will satisfy the standard. The numerical range provided in the standard for the longevity of the effectiveness of the control of residual radioactive materials allows for consideration of the various factors affecting the longevity of control and stabilization methods and their costs. These factors have different levels of predictability and may vary for the different sites." [Emphasis added.]

1.2. Implementation Objectives, Review Elements and Procedures

1.2.1 Objectives

It is the staff's position that the requirements and implementation guidelines of 40 CFR 192 necessitate that due consideration be given to geologic and seismologic processes that bear on engineering and hydrologic site-suitability considerations. Consequently, geologic-seismologic reviews of UMTRCA documents shall be directed toward the following objectives:

1. Determination of the site stratigraphy as input into engineering (ground failure) reviews as well as hydrologic (groundwater flow and contaminant migration) reviews and geomorphic evaluations;

2. Evaluation of the potential for geomorphic hazards, such as landslides, subsidence, and stream encroachment;

3. Estimation of earthquake-induced ground accelerations (vibratory ground motion) that could occur at the site;

4. Assessment of the potential for ground rupture (surface faulting) that could affect the tailings pile due to fault displacement;

5. Assessment of the potential for other types of tectonic hazards (e.g., volcanic activity) that could affe~ the site.

6. Evaluation of the natural resources exploitation history and/or potential of the site as input into geologic stability assessments. The goal of this evaluation shall be to determine how resource exploitation in the surface or subsurface of the site area may indirectly impact on the geologic stability of the pile, rather than to exclude the possibility of direct human disruption of the pile for purposes of resource recovery. The latter would go beyond the requirements of 40 CFR 192 (refer to Sec. III(B)(1) in particular), which are only meant to provide protection against casual human intrusion for misuse.

1.2.2 Review Elements

The staff considers the geologic-seismologic information in the documents reviewed to be acceptable if it satisfies the requirements and scope specified in this section.

1.2.2.1 Stratigraphy

Information pertaining to the formation, composition (including internal variability) sequence and correlation of the lithologic strata under the site and the region surrounding the site should be presented. The scope of stratigraphic investigations should be defined in part by the requirements of sections 1.2.2.2 and 1.2.2.3 and hydrology investigations. The level of stratigraphic understanding to be achieved shall be commensurate with the influence stratigraphy has on the determination that there is reasonable assurance that the remedial action will comply with the EPA standards.

Regional stratigraphic information may be obtained from published reports, maps, private communications or other sources. The information should be discussed, adequately referenced, and illustrated by regional surface and subsurface geologic maps, stratigraphic columns and cross sections. Sufficient detail should be provided to give clear perspective and orientation to the site-specific stratigraphic information to be presented.

Detailed data on the stratigraphic characterics of the site should be obtained from site-specific studies incorporating combinations of boring, trenching, geophysical investigations, and surface mapping. Plot plans that graphically show the locations of all site exploration localities should be provided. The limits of the site should be superimposed on the plot plans. Descriptions of the exploration and surveying techniques used should be furnished, as well as all geologic and/or geophysical logs, supplemented by ground-based and aerial photographs where appropriate.

The origin, depth, thickness, physical characteristics (e.g., color, sorting, texture), mineralogy, and degree of consolidation of each lithologic unit should be adequately described, noting zones of alteration or weathering profiles. The relationship of the site stratigraphy to the regional stratigraphy should be discussed. Selective stratigraphic cross sections (and/or fence diagrams) should be provided that incorporate the location of the borings or other exploratory locations from which the information in the sections was derived (i.e., "idealized" cross sections not based on discrete site-specific data are not adequate for the purpose of site characterization).

1.2.2.2 Geomorphic Hazards

Geomorphic investigations should include systematic analysis of regional and local landforms to provide evidence of geomorphic processes that may influence the stability of the site. As appropriate, such analysis should take into account the information discussed in sections 1.2.2.1 and 1.2.2.3 and that derived from hydrological investigations. The level of understanding of geomorphic processes to be achieved should be commensurate with the influence the processes have on the determination that there is reasonable assurance that the remedial action will comply with the EPA standards.

Chapter 5 of NRC NUREG/CR-3276 (Schumm and Chorley, 1983) provides a useful generic outline of standard procedures and methods for geomorphic site evaluations. In general, the physiographic (geomorphic) province(s) in which the site is located should be identified and described. This description should expound on the areal extent, distinguishing characteristics (e.g., elevation, relief) and major active processes modifying the present-day topography of the province(s) and should be supplemented by means of pertinent large and small scale topographic maps (e.g., USGS 7.5-minute and 2-degree USGS quadrangle maps).

Site-specific characterization studies should include aerial photography and detailed topographic mapping of the site and its vicinities. Topographic mapping of the disposal site area should be at a scale on the order of 1:2400, with a contour interval on the order of 1 foot. Such maps should be utilized

to generate geomorphic-hazards maps that delineate areas where landscape changes associated with drainage networks, slopes, rivers and piedmonts (as discussed in NUREG/CR-3276) may adversely affect site stability. Areas that may be subjected to subsidence due to natural or man-made subsurface conditions should also be identified (subsidence related to tectonic processes is addressed under section 1.2.2.3.3). Delineation of such areas should take into account the various factors influencing geomorphic processes such as relief, landform morphology, near-surface geology-pedology, and resident biota. Each relevant geomorphic process identified should be described, including (1) rate of activity, (2) frequency of occurrence, and (3) specific controlling mechanisms or factors.

1.2.2.3 Seismic and Tectonic Hazards

The level of understanding of seismic and tectonic processes to be achieved should be commensurate with the influence these processes have on the determination that there is reasonable assurance that the remedial action will comply with 40 CFR 192.

1.2.2.3.1 Vibratory Ground Motion

The staff considers the derivation of the maximum credible earthquake (MCE) and the resulting ground motion at the site to be acceptable if the processes and procedures in this section are followed. This does not mean, however, that NRC will exclude from consideration other methods and approaches to seismic hazard analysis that can be demonstrated by DOE to adequately address the requirements of 40 CFR 192.

1.2.2.3.1.1 Basic Information and Investigations Required

The required information and investigations provide an adequate basis for selection of the maximum credible earthquake (MCE), as defined in 10 CFR 40, App. A, Criterion 4(e), and determination of the resulting vibratory ground motion at the site. The size of the region to be investigated and the type of data pertinent to the investigations should be guided by the requirements of section 1.2.2.3.1.2. Data should be obtained by standard photogeologic analysis and field reconnaissance of the study area and from review of the pertinent literature. Investigative activities and technical information relating to the site should include the following:

(1) Determination of the structural geologic conditions at the site and the region surrounding the site, including its tectonic history;

(2) Identification and description of tectonic structures, particularly faults, underlying the site and the region surrounding the site, whether buried or exposed at the surface. (As used in this document, the terms "tectonic structure" and "fault" have the same meanings as defined in 10 CFR 100, App. A III (i) and (e), respectively.)

(3) Listing of all recorded earthquakes that have occurred in the tectonic province (as defined in 10 CFR 100, App. A III(h)) or provinces that would be expected to influence the local seismicity. This listing should include the date of occurrence of the earthquake, its magnitude, and the location of the epicenter. Since earthquakes have been reported in terms of various parameters such as intensity at a given location, and effect on ground, structures and people at a specific location, some of these data may have to be estimated by use of appropriate empirical relationships;

(4) Identification of epicenters or locations of highest intensity of historically reported earthquakes, where possible, with tectonic structures. Epicenters or locations of highest intensity which cannot be reasonably identified with tectonic structures shall be identified with tectonic provinces.

1.2.2.3.1.2 Determination of Seismic Hazard Parameters

Selection of the maximum credible earthquake (MCE) and of the resulting ground motion at a site should incorporate the following steps:

Step (1), Determination of the Maximum Peak Horizontal Acceleration for Earthquakes Unassociated with Known Structures. For those earthquakes not associated with a known tectonic structure, the largest event that has occurred in each of the tectonic provinces that would be expected to influence the seismicity of the site should be identified. For each of these earthquakes, the peak horizontal acceleration at the site should be determined by using an accepted state-of-the-art attenuation relationship between earthquake magnitude and distance. Joyner and Boore, 1981, Campbell, 1982, and Nuttli, 1983, in Bernreuter et al., 1984, are examples of acceptable relationships. In applying these relationships, site-to-epicenter distances for each earthquake should be set equal to the larger of two values: (a) 10 km, or, (b) the closest actual distance of a given province from the site. The acceleration value adopted should be the mean-value plus one-standard-deviation (i.e., 84th percentile value).

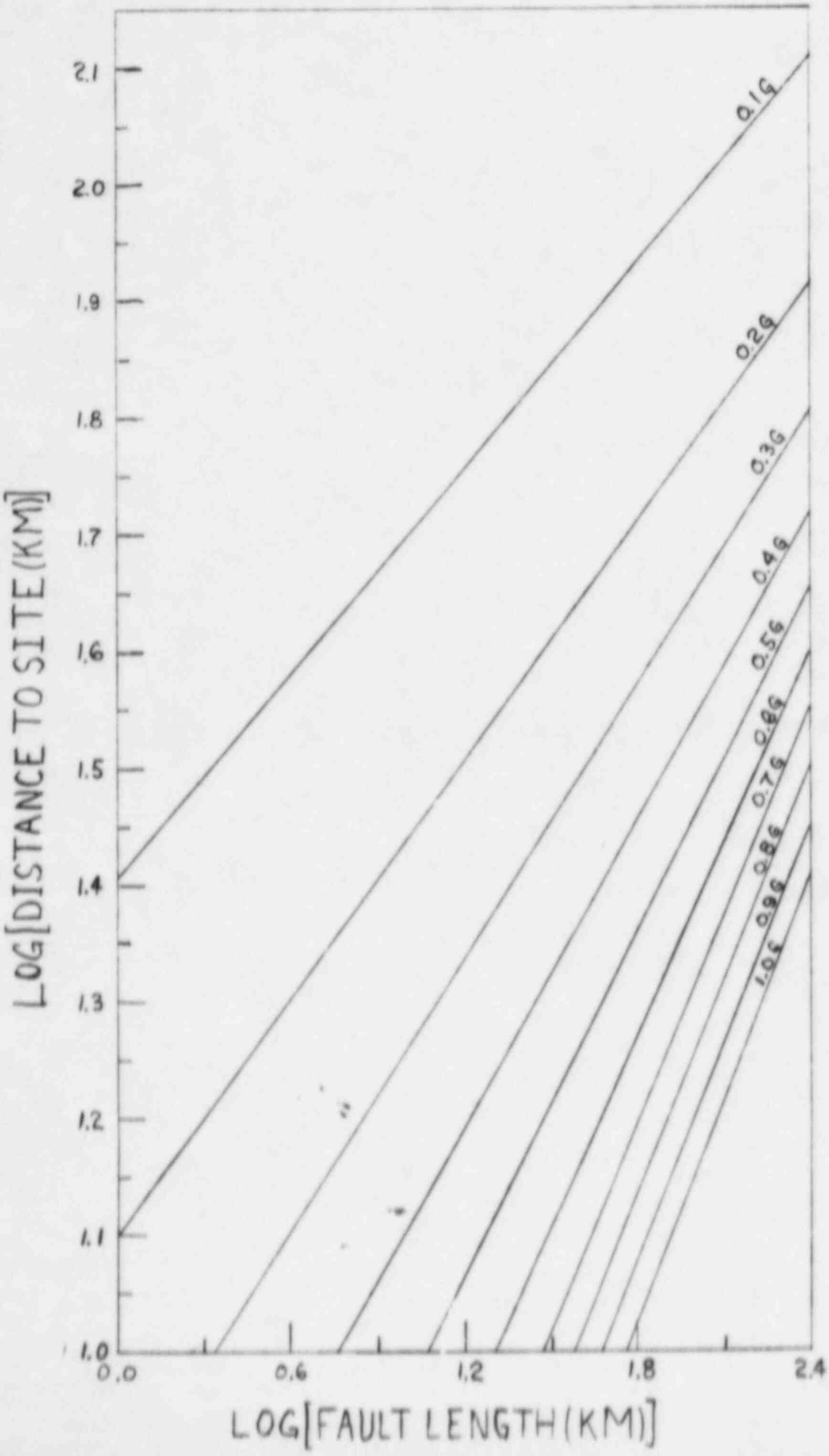
The maximum peak-horizontal bedrock-acceleration value derived through this exercise should be compared with the projected maximum-practical design-acceleration for the tailings embankment. If the latter is greater than the

former, the viability of stabilizing the pile at the given site should be appraised before proceeding to steps (2), (3) and (4).

Step (2), Determination of Area for Fault Investigation and Identification of Faults to be Investigated. By reference to Figure 1 (derived from relationships of Joyner and Boore, 1981, and Bonilla et al., 1984.), which presents a family of curves relating fault lengths to closest fault-to-site distances for different accelerations, a determination should be made of where the curve for the maximum peak horizontal acceleration value obtained in Step 1 intersects the log fault length value of 2.4. For all faults within this area, the fault length and distance to the site should be noted. With th's information, it should be determined whether a point for a fault, plotted on Figure 1, lies above or below the acceleration curve corresponding to the maximum peak horizontal bedrock acceleration value obtained in Step 1. For points that fall above the curve, no further investigation is necessary. For points that lie below the curve, the maximum earthquake magnitude that can be associated with a particular fault should be determined using a relationship between the length of the fault and the size of the earthquake it could generate (assuming that the fault is seismogenic). Acceptable state-of-the-art relationships, such as those of Bonilla et al., 1984, or Slemmons et al., 1982 should be used. Ground motion should be attenuated to the site using the attenuation relationships described in Step (1).

Step (3), Identification of Capable Faults. For faults whose ground motion exceeds, as determined in Step (2), exceeds the maximum peak-horizontal acceleration determined in Step (1), a determination should be made of whether they are to be considered as capable faults. As used in this document, the term "capable fault" has the same meaning as defined in 10 CFR 100, Appendix A III(g). The DOE should evaluate whether or not a fault is a capable fault with respect to the characteristics outlined in paragraphs III(g)(1), (2), and (3) by conducting a reasonable investigation using suitable geologic and geophysical techniques (such as those outlined by Slemmons, 1977). The viability of stabilizing the pile at the given site, and the need to proceed with Steps (3) and (4), should be appraised when at any point in this process a capable fault is identified that would produce ground motion at the site in exceedance of the projected maximum practical design acceleration for the embankment.

Step (4), Designation of the Maximum Credible Earthquake. From among all the earthquakes associated with capable faults, as derived in Steps (2) and (3), and the earthquakes identified in Step (1), the event that yields the maximum



LOG[DISTANCE TO SITE (KM)]
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.0
0.6
1.2
1.8
2.4
LOG[FAULT LENGTH (KM)]
0.1G
0.2G
0.3G
0.4G
0.5G
0.6G
0.7G
0.8G
0.9G
1.0G

FIG. 1

peak horizontal bedrock acceleration at the site should be designated as the maximum Credible earthquake (MCE).

1.2.2.3.2 Surface Faulting (Ground Rupture)

As used in this document, "surface faulting" refers to differential ground displacement at or near the surface caused by tectonism. It is distinct from non-tectonic types of ground disruptions such as landslides, fissures and craters. features. Fault investigations related to this issue should be directed at providing reasonable assurance that no capable faults are present within 3,000 feet of the embankment. Such investigations can be logically integrated with those undertaken to assess the hazards to the site from vibratory ground motion (section 1.2.2.3.1).

1.2.2.3.3 Other Tectonic Hazards

Investigations of other tectonic phenomena that could affect site stability should be an integral part of the overall tectonic hazard assessment. Two main items fall under this category:

(1) Volcanic activity; and

(2) Actual or potential surface or subsurface subsidence, uplift o collapse associated with regional or local tectonic deformational zones.

1.2.3 Review Procedures

The scope of UMTRCA document reviews by NRC is partly dependent on the stage of development of the report being reviewed.

1.2.3.1 Early Identification of Issues

Review of initial draft versions of Remedial Action Plans are primarily intended to evaluate the documents' completeness in relation to the review elements previously described, and to identify technical issues that should be addressed in later versions. The review will assess whether all geologic-seismologic representations and interpretations are based on adequate information.

1.2.3.2 Review of Remedial Action Plans

The Remedial Action Plans should contain sufficient information to allow the reviewer to make an independent assesment of the document's conclusions, i.e., the reviewer should be led in a logical manner from the data and premises given

to the conclusions that are reached without having to make an extensive independent literature search. Controversial information should not be ignored so as to enhance a particular position. The geologic terminology used should conform to standard reference works. Questions and comments transmitted to the DOE as a result of the staff review will identify issues that have not been addressed, or adequately documented by DOE, areas where staff interpretations differ from those of DOE, and issues that have not been sufficiently documented to permit the staff to concur with the conclusions reached by DOE.

Later reviews will concentrate increasingly more on evaluating DOE's responses to the initial round of questions and comments presented by the staff. Additional questions and comments for submittal to DOE are developed in regard to data or issues that have become apparent since the initial review or those that develop from the additional information provided in responses. Questions may arise from the reviewers discovery of references not cited in the documents which indicate conclusions or information that supports alternatives to those presented by DOE. When insufficient information is provided by DOE to support its interpretations and conclusions, and other reasonable or adequate alternative interpretations are indicated, the staff will request additional investigations or sensitivity studies. All through this process, the staff provides its review input to the Technical Evaluation Memorandum.

1.3 References Cited

Bernreuter, D.L., J.B. Savy, R.W. Mensing, and D.H. Chung, 1984, "Seismic Hazard Characterization of the Eastern United States: Methodology and Interim Results for Ten Sites," NRC NUREG/CR-3756, Appendix C-A.

Bonilla, M.G., R.K. Mark, and J.J. Lienkaemper, 1984, "Statistical Relations among Earthquake Magnitude, Surface Rupture Length, and Surface Fault Displacement," Bulletin of the Seismological Societv of America, ɔl. 74, pp. 2379-2411.

Cambell, K.W., 1982, "A Preliminary Methodology for the Regional Zonation of Peak Ground Acceleration," Proc. 3rd International Earthquake Microzonation Conference, Seattle, Washington, vol. 1, pp. 365-376.

Joyner, W.B. and D.M. Boore, 1981, "Peak Horizontal Acceleration and Velocity from Strong Motion Records Including Records from the 1979 Imperial Valley, California, Earthquake," Bulletin of the Seismological Society of America, vol. 71, pp. 2011-2038.

Schumm, S.A. and R.J. Chorley, 1983, "Geomorphic Controls on the Management of Nuclear Waste," NRC NUREG/CR-3276.

Slemmons, D.B., 1977, "State-of-the-Art for Assessing Earthquake Hazards in the United States: Report 6, Faults and Earthquake Magnitude," Miscellaneous Paper S-73-1, U.S. Army Engineer Waterways Experiment Station, Corps of Engineers, Vicksburg, Miss.

Slemmons, D.B., P. O'Malley, R.A. Whitney, D.H. Chung, and D.L. Bernreuter, 1982, "Assessment of Active Faults for Maximum Credible Earthquakes of the Southern California-Northern Baja Region," University of California, Lawrence Livermore National Laboratory publication no. UCID 19125, 48 p.