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40-8027
SUB-1010, Amendment No. 1

Kerr-McGee Corporation
ATTN: Dr. Frank K. Pittman, Director
Technical Services
Kerr-McGee Building
Oklahoma City, Oklahoma 73102

Category I; Priority Thy

Gentlemen:

Your application dated November 5, 1970 has been incorporated into the "demonstration" portion of your application for License No. SUB-1010. In order to provide continued continuity in the license for subsequent construction of waste disposal facilities Condition 17 has been added to License No. SUB-1010 to read as follows:

"17. In the location, design, construction, maintenance and inspection of waste disposal systems into which effluents containing radioactive material in excess of the limits specified in Column 2, Table II of Appendix B, 10 CFR Part 20 are disposed, the licensee shall follow the criteria established in Section 4, page 5 of the enclosure entitled "Information and Criteria Pertinent to Evaluation of Embankment Retention Systems." In addition, the licensee shall establish appropriately located test holes near retention ponds to check for seepage, if any, of radioactive materials."

All other conditions of this license shall remain the same.

FOR THE ATOMIC ENERGY COMMISSION

Original signed by
Robert L. Layfield

Robert L. Layfield
Materials Branch
Division of Materials Licensing

Enclosure:
"Information and Criteria
Pertinent to Evaluation of
Embankment Retention Systems"

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AEC LICENSING GUIDE

INFORMATION AND CRITERIA PERTINENT TO EVALUATION OF EMBANKMENT RETENTION SYSTEMS

U. S. ATOMIC ENERGY COMMISSION
SOURCE AND SPECIAL NUCLEAR MATERIALS BRANCH
DIVISION OF MATERIALS LICENSING
WASHINGTON, D.C. 20545

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N O T E

This guide has been compiled as an aid in the preparation of applications for source material licenses in which embankment retention systems are employed to prevent or control the release of radioactivity in concentrations exceeding those permitted to be released in 10 CFR 20. This guide is not intended as an interpretation of Commission regulations within the meaning of Section 40.6 of Title 10, Code of Federal Regulations, Part 40. Nothing contained in this guide may be construed as having the force and effect of United States Atomic Energy Commission regulations, nor as indicating that applications for appropriate licensing by the Commission which follow the recommendations of this document necessarily will be approved; nor as relieving any licensee from the requirements of Title 10, Code of Federal Regulations, Parts 20 and 40 or other pertinent regulations.

1. INTRODUCTION

The processing of unrefined source material, particularly the milling of uranium ore, results in the production of large volumes of liquid and solid wastes both of which usually contain concentrations of radioactive material in excess of those which may be released into unrestricted areas under the provisions of Section 20.106, Part 20, Title 10, Code of Federal Regulations, "Standards for Protection Against Radiation". Also, the wastes usually contain chemicals such as acids, alkalies, salts and organics, which could have an adverse effect on the environment if indiscriminately released. It is therefore necessary to contain such wastes so as to prevent or control their release to the environment. Containment may be accomplished by the construction of embankment retention systems. An additional advantage of containment is that it provides storage of solids for possible future reprocessing for other materials and permits the reclamation of liquids for reuse in ore processing.

The size and construction of these retention systems vary with the production capacity of the processing mill, the amount of liquid waste produced, the topography of the area in which the mill is located, and the amount of land available to the mill; for example, these systems may vary in size from a few acres to over 100 acres. Generally, the location of a retention system is selected to take maximum advantage of the natural contour of the area in which it is located, but it is usually necessary at some point to construct an earth and/or tailings embankment to contain the liquid waste. Earth embankments may be constructed for the purpose of retaining only liquid waste or for retaining both solid and liquid waste. In the latter case, the liquid and solid wastes are usually discharged to one area within the system so that the coarse solids continually build up in essentially the same area and the fine solids or slimes and liquids flow toward and are retained by an earth embankment.

Where tailings are used to build or increase the height of embankments, usually one or two techniques is employed - gravity or cyclone separation. When gravity separation is employed, tailings are transported to the retention system as a slurry and discharged near the inside edge of an initial earth embankment. The coarse solids settle out near the initial embankment and the fine solids or slimes and liquids drain to and are retained at the center or rear of the system. When the coarse solid tailings or liquids rise to within a few feet of the top of the embankment, the system is extended or raised by the use of a drag line and/or earth moving equipment. From time to time the embankment may be further raised in the same manner whenever required. In the case of cyclone separation, tailings are also transported to the retention system as a slurry and separated by truck or

trestle mounted cyclone separators. Truck mounted cyclones move slowly along the top of the embankment and extend the height of the embankment by depositing the coarse fraction of the tailings along the top and the slimes and liquids well within the retention systems. Trestle mounted cyclones perform the same operations but must be periodically moved along the embankment.

It is important that these embankment retention systems be constructed and maintained in accordance with sound engineering principles in view of their purpose to prevent or control the release of radioactive materials and chemicals to the environment. The Commission has developed criteria for the construction and maintenance of these earth and tailings embankments to be used in connection with the evaluation of the structural integrity and other safety features of these systems prior to the issuance of source material licenses and license renewals.

It is the purpose of this guide to specify information which the Commission will require in connection with the licensing of source material activities involving embankment retention systems. This information pertains primarily to the integrity of the retention system and is in addition to other information normally required by the Commission in support of applications for licenses authorizing milling activities, such as information on local meteorological conditions, geological and hydrological data, effluent survey programs, etc. The purpose of the guide is also to identify the criteria for the construction and maintenance of embankment retention systems that will be used by the Commission evaluating such systems. The criteria are necessarily general in nature since the characteristics of embankment systems may vary significantly from one location to another. Therefore, conformance with these criteria shall not be considered as relieving an applicant or licensee of his responsibility for assuring that his system is adequate from a structural integrity and radiological safety standpoint.

The Commission may request additional information beyond that specified from applicants or licensees if such information is necessary to provide reasonable assurance that the applicant or licensee has established an adequate system. (See § 40.31(b) of 10 CFR 40.) Such requests may be avoided by a thorough study of Commission regulations and this guide prior to submitting information to the Commission.

An applicant or licensee may incorporate by reference information contained in applications, statements and reports previously filed with the Commission's Division of Materials Licensing, provided that such references are clear and specific. (See § 40.31(e) of 10 CFR 40.) In order to be clear and specific, the aforementioned references must indicate by date, page and paragraph what information the applicant wishes to reference and how such information is applicable to the license application.

2. AUTHORITY

The Atomic Energy Act of 1954, as amended, charges the United States Atomic Energy Commission with, among other things, responsibility for regulating the receipt, possession and use and transfer of source material. The Commission is authorized to establish by rule, regulation or order such standards and instructions to govern the receipt, possession and use of source material as it may deem necessary or desirable to protect health or to minimize danger to life or property.

In the performance of its regulatory functions, the Commission has promulgated the regulations contained in Title 10 of the Code of Federal Regulations. The following regulations are particularly pertinent to the subject of this guide:

1. Part 20, "Standards for Protection Against Radiation."

2. Part 40, "Licensing of Source Material."

Amendments to the regulations are published from time to time in the Federal Register. Current copies of Commission regulations may be obtained from the Division of Materials Licensing, U.S. Atomic Energy Commission, Washington, D.C. 20545, or from any of the following U.S. Atomic Energy Commission Division of Compliance Regional Offices:

Director, Region I
Division of Compliance, USAEC
970 Broad Street, Room 806
Newark, New Jersey 07102

Director, Region II
Division of Compliance, USAEC
230 Peachtree Street, N.W.
Suite 818
Atlanta, Georgia 30303

Director, Region III
Division of Compliance, USAEC
799 Roosevelt Road
Glen Ellyn, Illinois 60137

Director, Region IV
Division of Compliance, USAEC
10395 W. Colfax Avenue
Denver, Colorado 80215

Director, Region V
Division of Compliance, USAEC
2111 Bancroft Way
Berkeley, California 94704

3. INFORMATION REQUIRED

In addition to the information required by Section 40.31, 10 CFR 40, applications for specific source material licenses which involve the use of embankment retention systems for holding wastes containing radioactive material in concentrations greater than

those permitted to be released pursuant to Section 20.106, 10 CFR 20, shall contain the following information as applicable:

A. Drawings showing the layout in plan; typical cross-sections of all embankments showing proposed design, and if applicable, anticipated future extensions; and other pertinent design details. Embankment design should include information on heights, top width, side slopes, freeboard, seepage control, and protection of embankment surfaces as well as foundation design.

B. A design analysis of the integrity of the proposed system including, as applicable, the results of soil tests, geologic exploration, nature of foundation materials stability investigations and characteristics of fill material as well as a description of the construction methods and specifications.

C. An evaluation and discussion of conditions that might lead to accidental release of the waste, the probable environmental effects of such release, and proposed program of inspection and maintenance to prevent such an accidental occurrence.

4. EMBANKMENT RETENTION SYSTEM CRITERIA

The Commission will take the following factors into consideration in evaluating for approval the information submitted pursuant to Section 3 of this guide:

A. Location

(1) The site should be subject to the control of the licensee so as to permit entry only of authorized personnel thereto.

(2) The site should not occupy the channel of any permanent watercourse unless a provision has been made for permanent diversion of such water course around the site.

(3) The site should be permanently protected against run-off when necessary, from the surrounding drainage area by the provision of diversion channels to prevent such run-off from entering or washing out the embankments.

(4) A minimum distance of 200 feet should be maintained between the embankments of any permanent flowing

watercourse at flood stage to minimize percolation effects unless information is submitted for satisfying a closer location.

B. Design

(1) Foundations - Foundations should be investigated to determine that they have suitable strength and permeability characteristics for the embankment proposed, including anticipated future extensions. A foundation of rock or graded sand and gravel is normally considered to have satisfactory strength for small embankments (under 25 feet in height). Foundations of alluvial deposits, which have not been consolidated under appreciable loads, and those of fine and uniform sands or of plastic clays must be given careful investigation and treatment to insure safety of the embankment.

(2) Embankments

(a) Construction material - The embankment material used in the construction of earth embankments may be natural soil, usually borrow soil found nearby, suitable for the construction of such systems. Coarse tailings material may be used to extend an earth embankment during construction of a tailings embankment provided design and construction methods specified in this guide are followed.

(b) Top width - The mimimum top width of an embankment should be eight feet. As the height of the embankment increases the top width should be increased as specified in Table I below. It may be necessary to further increase the top width if the embankment material is susceptible to erosion or sloughing.

TABLE I - RECOMMENDED MINIMUM TOP WIDTH FOR EMBANKMENTS

Height of Embankment (feet)	Minimum Top Width (feet)
8 to 12	10
13 to 20	12

TABLE I (cont.)

Height of Embankment (feet)	Minimum Top Width (feet)
21 to 30	15
Over 30	20

(c) Side slopes - In most cases the type of material that is readily available for embankment systems will require that side slopes on the upstream face (i.e., in contact with the liquid) have a slope ratio between 4 to 1 and 2 1/2 to 1 and on the downstream face of the embankment between 3 to 1 and 2 to 1. Table II below contains recommended maximum slopes for embankments constructed of various materials. (For further details of these and other commonly used soil materials, reference is made to the chart, "Unified Soil Classification, Including Identification and Description", adopted by Corps of Engineers and Bureau of Reclamation, January 1952).

TABLE II - RECOMMENDED HORIZONTAL TO VERTICAL SIDE SLOPE RATIOS FOR EMBANKMENTS

Embankment Materials	Upstream Face	Downstream Face
Homogeneous Sand Clay	2-1/2 to 1	2 to 1
Coarse Sand with compacted clay or structural core wall	3 to 1	2-1/2 to 1
Sand-gravel mixture with compacted clay or structural core wall	3 to 1	2 to 1
Homogeneous Silty Clay	4 to 1	3 to 1
Homogeneous Sandy Loess	3 to 1	3 to 1
Coarse Tailings (dry)	2-1/2 to 1	2 to 1

Where coarse tailings material is used to increase the height of an initial earth embankment, the Commission will consider the material as purely frictional with an angle of internal friction of 33 dgrees (i.e., a natural slope of approximately 1-1/2 to 1). This will mean that the downstream face of the embankment should have a total slope ratio of approximately 2 to 1. Berms may be employed in the construction of the embankment to satisfy this side slope ratio, provided the berms are at least eight feet in width, the height of each embankment section does not exceed 18 feet, and the slope of each tailings embankment section is at least the natural slope of the material.

The recommended slopes in the above table may have to be flattened when necessary to spread the load so that the maximum unit stress induced in the foundation will be less than the shear strength of the foundation material or when full knowledge is not available on shear strength and seepage flow.

(d) Freeboard - The freeboard height of the embankment above the maximum liquid level should not be less than three feet. Consideration should be given to future compaction and settlement of the embankment and to frost penetration which would materially effect the possible freezing and cracking of the embankment above water level.

(3) Seepage Control - Suitable methods should be employed to minimize the effect of seepage on the embankment and its foundation. Methods of controlling seepage include toe drains, filter layers, impervious cut-offs or blankets, and corewalls. Seepage along the contact surface between the foundation and the embankment should be minimized by removal of all organic material such as sod and top soil and where appropriate the installation of a "key" trench.

(4) Protection of Embankment Surfaces - Embankment surfaces should be protected against erosion by the use of such means as vegetation, berms, logs, or riprap. The method of protection used must be based upon the susceptibility to erosion.

(5) Protection Against Environmental Release - Where deemed necessary, provisions such as the use of additional surrounding embankments or sumps should be made for capturing or holding liquid waste resulting from seepage through the embankment or unexpectedly released by failure of the primary embankments.

Unprotected surfaces on the top or within the retention system, such as inadequate crust formation, should be provided with an effective means of dust control, such as a sprinkler system for periodically wetting down these surfaces, a form of cement, asphalt or other binder for a more permanent sealer of the surfaces, or vegetation is found feasible.

C. Construction Methods

Construction of the earth embankment should be started only after clearing and grubbing operations are completed and the foundation has been properly prepared. Embankment material should be free of sod, roots, stones over six inches in diameter, and other material should not be placed in embankments and embankments should not be constructed on frozen foundations. The placing and spreading of embankment material should be started at the lowest part of the section under construction and the embankment carried up in horizontal layers not exceeding eight inches in thickness. Insofar as possible, these layers should be uniform elevation and extend over the entire area of the fill. The distribution and gradation of materials throughout the embankment should be such that there are no lenses, pockets or streaks created, and the moisture content of the materials should be proportioned for maximum degree of compaction. Proper compaction of the embankment material should be achieved by the use of equipment designed for this purpose, usually a sheepsfoot roller. The travel of excavating equipment is generally not considered an adequate method for obtaining compaction. If the sheepsfoot roller is used, it should be weighted to give a unit pressure of not less than 200 pounds per square inch of the total surface area of the feet simultaneously in contact with the embankment. Usually six passes of the roller over each individual layer of material are sufficient to obtain good compaction. For relatively low embankments, under 25 feet in height, the adequacy of compaction may be determined by observation of the roller in action. For embankments over 25 feet in height, field control over compaction should be more precise and the embankment should be rolled until some predetermined degree of compaction is obtained, usually 90 to 95 percent of maximum density as determined by appropriate compaction tests.

Tailings embankments should be started with an initial outer earth embankment as described previously and may be raised when necessary by using coarse tailings material. The tailings, usually in the form of a slurry, should be deposited within the system in such a way that coarse sands settle out first near the embankment, while the fines or slimes are carried away toward the liquid pond area where the liquid is retained. Observations

should be made and records kept of the deposition of tailings as well as sampling of the tailings near the embankment to determine its properties for use in building up the embankment. In order to gain the maximum shear strength from this material, it should have as low a moisture content as possible during embankment extension and all subsequent seepage flow should be minimized. Proper construction methods should be observed as specified above.

D. Maintenance and Inspection

A program of maintenance and inspection should be established to detect and repair environmental and other effects which might tend to lessen the integrity of the embankment system.