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U.S. ATOMIC ENERGY COMMISSION

REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 3.11

DESIGN STABILITY OF EMBANKMENT RETENTION SYSTEMS FOR URANIUM MILLS

A. INTRODUCTION

Each licensee who processes or refines ore in a uranium mill is required to comply with the provisions of 10 CFR Part 20, "Standards for Protection Against Radiation." Section 20.106, "Concentrations in Effluents to Unrestricted Areas," generally provides that licensees shall not possess, use, or transfer licensed material so as to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix B, Table II of Part 20.

The milling of uranium ore results in the production of large volumes of liquid and solid wastes (tailings) both of which usually contain concentrations of radioactive material in excess of those specified in Table II, Appendix B of Part 20. It is therefore necessary to confine such liquid and solid tailings and prevent their release to the environment. Confinement is usually accomplished by the construction of an embankment retention system. This regulatory guide specifies acceptable methods of analyzing the stability of embankments, minimum acceptable safety factors that are applicable during construction and use of embankment retention systems, and acceptable surveillance procedures.

B. DISCUSSION

The design, construction, and size of embankment retention systems for uranium mill tailings will vary significantly from one milling location to another. The characteristics of these systems will depend on such diverse factors as the capacity of the mill, the type of ore processed, the amount of waste produced, the amount of solution impounded, the type of milling process, the topography of the area in which the mill is located, the amount of land that is available for the retention system, the permeability of the soil on which tailings are deposited, and the materials with which the embankments are constructed. It is important that these embankment retention systems be designed and constructed in accordance with sound engineering principles to assure that they will maintain their structural integrity. Several analytical methods are available that may be used to determine the stability of embankments for various heights and slopes, seepage conditions, and soil strength parameters. The results of such stability analyses should demonstrate an acceptable factor of safety against failure for all pertinent design conditions.

C. REGULATORY POSITION

1. Basic Design Considerations

Embankment retention systems for uranium mill tailings should be designed to assure structural integrity during the intended lifetime of the system. The stability of an embankment retention system should be evaluated for construction and operating conditions utilizing the expected in situ engineering properties of the foundation and embankment materials and pertinent geologic information.

2. Methods of Stability Analysis

The acceptable methods of analyzing the stability of embankments are the adaptations of the circular arc method. Other proven methods of analyzing stability, such as the sliding wedge method, may be used if they are more applicable to the particular situation being considered.

3. Design Conditions for Analysis

Stability analyses of embankments should be performed for the following design conditions:

a. End of Construction (upstream and downstream slopes):

b. Partial Pool (upstream slope only);

c. Maximum Storage Pool (downstream slope only); and

d. Earthquake (upstream and downstream slopes).

4. Minimum Factors of Safety

Stability analysis of embankments, employing the methods specified in regulatory position C.2. above, should demonstrate an acceptable factor of safety against failure for all pertinent design conditions. Minimum acceptable factors of safety are given in the following table.

Design Condition	Minimum Factor of Safety
End of Construction	1.4
Partial Pool	1.5
Maximum Storage Pool	1.5
Earthquake (for all of the above conditions with seismic loadings*)	1.0

*Selection of the appropriate seismic coefficient should be based on the maximum earthquake determined on the basis of historic seismicity at the site.

5. Surveillance

A regular program of surveillance and maintenance should be established to detect and repair damage resulting from environmental or other effects which might tend to lessen the integrity of the embankment retention system. Generally, visual inspections on a regular basis are acceptable unless circumstances indicate otherwise. Repair of damage resulting from any cause which might tend to lessen the integrity of the embankment retention system should be performed as soon as possible.

Instrumentation may be required for monitoring the status and safety of the embankments. The basic instruments needed for such monitoring are piezometers for measuring pore-water pressure and slope indicators for measuring horizontal and vertical movement in the embankments. The extent to which such instrumentation need be installed will be evaluated by the Commission on a case-by-case basis.