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DESIGN OF LONG-TERM EROSION-PROTECTION COVERS FOR RECLAMATION OF URANIUM MILL SITES

A. INTRODUCTION

Uranium mill licensees are required by paragraph 20.1(c) of 10 CFR Part 20, "Standards for Protection Against Radiation," to make every reasonable effort to maintain radiation exposures and releases of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable. Additional criteria and standards for environmental protection may be found in the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (PL 95-604) and in § 20.106, "Radioactivity in Effluents to Unrestricted Areas," of 10 CFR Part 20. Recently, the Environmental Protection Agency (EPA) established standards (40 CFR Part 192) for the disposal of uranium mill tailings for both inactive (Title I) sites and active (Title II) sites. These standards establish the criteria to be met in providing long-term stabilization.

To help operators meet Federal guidelines, this regulatory guide describes design practices the NRC staff has found acceptable for providing long-term protection against erosion of stabilized uranium mill tailings. This guide focuses principally on the design of rock and vegetative covers to provide the necessary long-term protection.

Any guidance in this document related to information collection activities has been cleared under OMB Clearance No. 3150-0014.

This regulatory guide and the associated value/impact statement are being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. They have not received complete staff review and do not represent an official NRC staff position.

Public comments are being solicited on both drafts, the guide (including any implementation schedule) and the value/impact statement. Comments on the value/impact statement should be accompanied by supporting data. Comments on both drafts should be sent to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch, by .

Requests for single copies of draft guides (which may be reproduced) or for placement on an automatic distribution list for single copies of future draft guides in specific divisions should be made in writing to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Director, Division of Technical Information and Document Control.

** The consequences of damage due to malfunction of the erosion protection do not justify providing a 99% sure design. A reliability of 90% will be satisfactory for this case, corresponding to a probability of occurrence of 0.10.

B. DISCUSSION

Because uranium mill tailings and byproduct materials may have potential detrimental effects on public health and safety, these hazardous materials must be contained in accordance with EPA guidelines (40 CFR Part 192). These regulations prescribe criteria for long-term reclamation and design of protective covers for both inactive (Title I) sites under the UMTRCA program and active (Title II) sites currently licensed by the NRC.

The purpose of a protective cover is to prevent wind and water erosion of tailings, prevent biotic intrusion, and ensure the sustained functioning of the tailings disposal system. However, little information exists on the long-term performance of such covers. Erosion due to wind and water is difficult to assess quantitatively, and site-specific factors (such as rock durability) are difficult to factor into any long-term performance evaluation.

Because of design difficulties, the NRC staff has concluded that the goal of any design for long-term stabilization to meet the EPA criteria should be to provide overall site stability for long time periods with no routine maintenance.* The NRC staff recognizes, however, that such designs may not be practical in some cases and that some monitoring and maintenance will probably be needed.

Several long-term stability investigations (Refs. 1 through 4) have indicated that the most disruptive natural phenomena affecting long-term tailings stabilization are likely to be wind and water erosion. These studies have also indicated that wind and water erosion can be mitigated by a rock cover of reasonable thickness (or a rock and vegetative cover) and that the size of the rock on the protective cover will normally be controlled by the precipitation or flood event. Therefore, the selection of the design flood event assumes major importance in the overall reclamation plan.

In considering the selection of the flood event on which to base the reclamation plan, the NRC staff has relied on experience and information reported in a long-term stability investigation (Ref. 1). It has been shown that, to provide a level of risk corresponding to a probability of occurrence of about ~~0.01 or less~~ 0.10 **, the design flood for a period of 200 years would require

*The consequences of damage due to malfunction of the erosion protection do not justify a no routine maintenance design.

** see Note at top of Page.

a recurrence interval of about ~~20,000~~ 2,000 * years~~. or more~~. Extrapolation of limited data bases to this time frame ~~is very uncertain~~ may be uncertain in some cases. Because the probable maximum flood (PMF) and the probable maximum precipitation (PMP) are based on site-specific physical meteorological limitations that eliminate the uncertainties associated with extensive extrapolation of limited data bases, the staff concludes that it is reasonable and prudent to use these phenomena for the long-term design of reclamation covers. **Not justified by consequences of exceedance.

In general, proper site selection is needed to minimize the erosive forces produced by a PMF.** However, many existing uranium mill sites are poorly sited; some are located immediately adjacent to large, swiftly flowing streams with a high potential for extensive erosion. For these existing sites, the PMF forces may be so large that they preclude economical long-term stabilization. In these cases, the NRC staff has concluded that the design basis flood event for long-term stability considerations should still be the PMF. However, if it is determined that implementation of such a design would be impractical, any alternative approach using a flood smaller than the PMF would have to consider increased levels of maintenance, repair, and environmental damage. In such cases, the staff may also consider that certain conservatisms normally present in the determination of design basis floods or flood velocities may be adjusted in favor of more realistic calculations and that such reductions may not significantly affect the overall safety and stability of the site. The staff will determine on a case-by-case basis whether there is reasonable assurance that the site stabilization program, as designed, will be effective for a minimum of 200 years and thus will meet EPA regulations. ***This procedure is more cumbersome and time consuming than justified.

The suggested criteria in this guide will apply principally to existing Title I and Title II sites. For new sites, careful consideration should be given to siting and the various factors that must be considered following reclamation. If it is necessary to provide above-grade tailings disposal, the sites should be located near available sources of rock and in locations where long-term erosion problems are minimal.

A serious threat to stability at any given site is likely to be gully erosion resulting from runoff from intense local precipitation. To ensure long-term stability, it is important to prevent localized erosion and the

* See note at top of page 2.

formation of rills and gullies. Research performed for the NRC staff (Ref. 1) has concluded that if localized erosion and gullying occurs, damage to the cover will occur rapidly, probably in a time period shorter than 200 years. Therefore, care must be taken in the design to ensure that flat, vegetated slopes or rock protection are provided to prevent the initiation of gullies both on the top and the sides of the pile (Ref. 4).

At the present time, there are no known quantitative methods to determine the rock cover requirements to prevent the initiation of gullies. Because vegetative covers may not be self-sustaining and effective over long time periods (Refs. 1 and 3), especially in the arid Western United States, it has become necessary to develop a procedure to determine rock cover requirements that will prevent gullying. The NRC staff has developed a method for designing erosion-protection covers to prevent the development of gullies. This method, illustrated in Appendix A to this guide, is based on staff licensing and review experience and pertinent hydraulic engineering principles. *See Comments in App. A. It was developed to provide cover design criteria that reflect an appropriate degree of conservatism, taking into consideration the following:

1. Some degree of flow concentration will always occur as runoff progresses down an embankment slope; it is unlikely that evenly distributed sheet flow will occur from top to bottom on the slope. The flow concentration could be initiated by differential settlement of the tailings, normal settling of the rock layer, and random flow processes. **Settlement can be allowed for by overbuilding. Random flow processes will not concentrate flow if rock size is sufficient to prevent initiation of gulleying.

2. The flow over the rough rock layer will be turbulent; shear forces will be increased as a result. ***Not necessary to assume laminar flow.

3. Shear stresses, especially at the toe to the embankment, may be significantly increased by energy dissipation processes such as hydraulic jumps.

It should be recognized that the computational procedures outlined in Appendix A were developed in a conservative manner based on staff experience with damage to erosion-protection designs during the occurrence of relatively minor storm events. Of necessity, this procedure attempts to account for the limited quantitative data base available to document long-term degradation,

the known survivability of many rock-protected structures, and the questionable ability of vegetative covers to be self-sustaining in arid areas.

The example calculation given in Appendix A* was selected to represent a typical reclaimed tailings impoundment. Based on our examination of other mill sites and on general rainfall/runoff relationships in other arid areas, it is unlikely that the amount of rock protection required at other similar sites will be significantly greater than that required at this "typical" site, provided runoff from the top of the pile is properly considered.

*See comments in App. A

The NRC staff is currently funding efforts in those areas where quantitative predictive methods are not available, such as estimation of gully erosion, prediction of streambank erosion during major floods, and design of poor-quality rock protection for longevity. Until such methods are available, it is necessary to exercise conservatism in the design of protective covers, consistent with the needs of industry, good engineering judgment, and the health and safety of the public.

C. REGULATORY POSITION

A cover layer for the protection of stabilized uranium mill tailings should be capable of meeting the long-term stability requirements of 40 CFR Part 192. The criteria outlined below for the design of such protective covers for reclamation of tailings impoundments have been found acceptable by the NRC staff.

Some of these design procedures have been developed because of the unavailability of specific documented, quantitative, analytical procedures. These criteria are based on NRC staff experience with tailings impoundments and rely extensively on experience and judgment. If alternative methods are proposed for staff review, they will be considered on a case-by-case basis.

1. GENERAL INFORMATION SUBMITTALS

For the cover layer design selected, the engineering data and analyses related to the design and construction of the protective cover should be provided for NRC staff review. These data include:

a. Drainage areas of principal watercourses and drainage features.*

b. Drainage basin characteristics, including soils, vegetative cover, local topography, and flood plains.*

c. Maps and aerial photographs showing the impoundment location and the upstream drainage areas.*

d. Information regarding rock that is available, including rock types, rock characteristics, rock availability, and rock quality.

e. Site geomorphological characteristics.

f. Drawings and photographs of impoundment features.

g. Location, depth, and dimensions of tailings.

h. Physical properties of the radon suppression cover, tailings embankment, rock cover, and foundation materials, including results of laboratory and field tests.

i. Pertinent construction records, including construction control tests, construction problems, alterations, modifications, and repairs.

j. Principal design assumptions and analyses, including hydrologic, hydraulic, and stability analyses.

2. DESIGN OF PROTECTIVE COVERS FOR LOCAL INTENSE PRECIPITATION

The slopes of a reclaimed tailings impoundment should be designed to resist the effects of local intense precipitation to prevent sheet erosion and

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*Data should be mapped on 7.5-minute U.S. Geological Survey quadrangle maps (15-minute quadrangles may be used if large-scale maps are not available). Maps of similar scale may be substituted for U.S. Geological Survey maps if comparable levels of topography and cultural data are maintained.

subsequent formation of rills and gullies. In addition, diversion ditches and drainage features located on or near the reclaimed pile should also be protected from such storm events. Where practicable, erosion protection should be designed to resist the effects of precipitation as intense as the PMP.* See second comment on Page 3.

2.1 Vegetative and Soil Covers

Reference 4 provides general guidance on the design of vegetative and soil covers. Based on the results of several studies (Refs. 1 and 3), it is unlikely that a self-sustaining vegetative cover for long-term erosion protection can be provided on steep embankment slopes in the arid portions of the Western United States. However, self-sustaining vegetation may provide reliable long-term stabilization in semiarid to humid climates on relatively flat slopes (Refs. 1 and 4).** In more arid climates where self-sustaining vegetation is marginal (less than 50 percent vegetative cover), rock cover should be provided if practical.*** ** Define "relatively flat slopes".
Povision of sacrificial material should be considered, where erosion loss per year is small.

However, the staff will approve the use of vegetative covers when the following conditions are met:

a. Suitable rock is not locally available and the cost of providing adequate protection to meet 40 CFR Part 192 requirements is excessive.

b. The velocity produced by a concentration of PMF flows on the face of the embankment is less than the erodible velocity of the soils on the embankment slopes or the total soil cover thickness provided is such that, if gullying occurs and the gully depth and the gully slopes eventually reach stable levels, no tailings have been eroded (see Appendix A for computations and analyses needed to document this conclusion). The latter condition would normally apply only in those cases in which it is not practicable to flatten or protect an existing dam embankment and the tailings are located a considerable distance from the embankment face.

c. In general, the slopes of the reclaimed impoundment are similar to natural soil slopes currently existing in the site area (see Appendix A). If soil types are similar, this should provide a reasonable indication of the stable slope for a given area.

2.2 Rock Covers

In the arid portions of Western United States, where the survivability of a vegetation is marginal, the use of a rock cover is considered by the NRC staff to be the most desirable method for satisfying the long-term stability requirements of 40 CFR Part 192. In arid areas where rock is locally available, a rock layer should be provided to prevent long-term erosion due to wind and surface-water runoff.

An acceptable analytical method for determining the stable slope of a vegetative cover and designing a rock cover to resist sheet erosion and thus prevent gullying may be found in Appendix A.* See comments in App. A.

Reference 3 provides guidance for the design of rock riprap protection for ~~onsite~~ diversion ditches. Because the design goal is to provide long-term protection without the need for routine maintenance, appropriate conservatism should be applied in the selection of various hydrologic input parameters, such as Mannings "n" values, factors of safety, times of concentration, and rainfall intensities. It should be noted, however, that the design of the rock cover for an embankment will often be controlled by the velocities produced by a PMF** in a nearby river (see Section C.3).

3. DESIGN OF ROCK COVERS TO RESIST FLOODING BY NEARBY STREAMS

The slopes of a reclaimed tailings embankment should be protected from the effects of flooding of nearby watercourses. Where floods impinge on the embankment slopes with erosive velocities, erosion protection should be provided to resist the velocities produced by a PMF.*

** See second comment on Page 3.

Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants," provides guidance for the determination of PMF flows. Reference 5 may be used to compute water surface profiles and local velocities. Guidance for the design of riprap may be found in References 6 and 7.

In designing the riprap layer to resist local PMF* velocities, judgment must be exercised in selecting an appropriate factor of safety. A safety factor of about 1.5 times the computed shear stress should be used.** The use of less conservative safety factors will be reviewed on a case-by-case basis. The acceptability of such safety factors will depend on other considerations such as other conservatisms in the design, the additional cost of applying the recommended safety factor, expected turbulence or nonuniform flow, and the physical configuration of the reclaimed pile.

4. SELECTION OF THE BEST AVAILABLE ROCK

Investigations should be conducted to identify several sources of available rock within a reasonable distance of the site. The suitability of these rocks as protective covers should then be assessed by laboratory tests that determine the physical characteristics of the rocks. Several tests such as those listed in Reference 3 should be performed to classify the rock as being of poor, fair, or good quality and to assess the expected long-term performance of the rock.

In those cases in which rock is required for cover material or gully protection and only rock of less-than-good quality is available, increases in the average rock size and riprap layer thickness may be necessary. The determination of such increases will be based largely on engineering judgment and experience taking into consideration the added safety margins and costs associated with the increases.

Where rock of good quality is available, the cover design should incorporate this rock. Depending on the degree of conservatism provided in the overall design, it is likely that no increase in average riprap size or layer thickness will be necessary. In general, any increase in thickness of the rock cover layer should be based on the expected performance of the rock in resisting

* See second comment on Page 3.

** Safety factor should depend on uncertainties in analysis. Its purpose is to account for the probable range of uncertainty in the variables involved.

physical and chemical weathering. For a given riprap ~~layer thickness,~~ the ~~average rock size (D_{50}) in the~~ layer should be as ~~large as practicable~~ taking into consideration, ~~the ability of the layer to meet gradation limits.~~

5. DESIGN OF COVERS TO RESIST WIND EROSION

It has been observed in most areas of the United States, including the arid Western United States, that erosion due to surface-water runoff produces a greater potential for soil loss than does wind erosion. Consequently, if adequate protection is provided for gully and concentrated sheet flow erosion, losses by wind erosion will be ~~minimal~~ (Ref. 1).

However, if a protective rock cover is not provided, it will be necessary to estimate wind erosion potential. Reference 8 provides a method acceptable to the NRC staff for estimating wind erosion losses. If these losses are significant, it may be necessary to make design changes to reduce the erosion potential.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants regarding the NRC staff's plans for using this regulatory guide.

The proposed guide has been released to encourage public participation in its development. Except in those cases in which an applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method to be described in the active guide reflecting public comments will be used in the evaluation of long-term reclamation and protective cover site plans for both Title I and Title II sites submitted after the implementation date to be specified in the active guide.

APPENDIX A

SAMPLE CALCULATIONS FOR RIPRAP AND SOIL COVER DESIGNS

STATEMENT OF PROBLEM

Determine if a vegetative and soil cover can withstand expected sheet erosion; if not, design a protective riprap layer to resist the expected shear forces.

PROPOSED DESIGN

XYZ Uranium Co. proposes to provide an unprotected 10-foot-thick soil cover over a reclaimed tailings impoundment located in northwestern New Mexico near Farmington. The embankment slopes are 1 Vertical on 5 Horizontal; all slopes are about 60 feet high and about 300 feet long. The soil cover will resist a sheet flow velocity of 4 feet per second based on the grain size and the cohesive properties of the soil. (See Note 1.)

Step 1 - Determine Flow Rate

The soil cover should be designed to resist concentrated sheet flow at the embankment toe. For the purposes of computing the sheet flow velocity, it should be assumed that, because of differential settlement or other phenomena, flow down the embankment slopes will be concentrated in several areas. A flow concentration of four to five times the normal sheet flow rate should be assumed to occur. (See Note 2.)

*Attached Chapter 5 from MKE Design Procedures covers gullying. If rock size is sufficient to prevent gulleying & embankment is sufficiently over-built to compensate for settlement, flow will not be significantly concentrated

1. Compute Drainage Area

For an assumed 1-foot-wide section, the drainage area A is computed by

$$A = (300)(1) = 300 \text{ ft}^2$$

2. Compute Time of Concentration

Assuming that the average sheet flow velocity down the entire length of the slope is equal to ½ of the maximum design velocity of 4 feet per second,* the time of concentration tc may be estimated by

$$tc = \frac{300}{2} = 150 \text{ sec or } 2.5 \text{ min}$$

However, use tc = 5 min. (See Note 3.)

*Better estimates of overland flow velocities are available, such as the SCS (upland) method. This method gives 3.2 ft/sec. for 20% slope and short grass pasture.

3. Determine PMP and Rainfall Intensity

Using Reference 9,** the 1-hour PMP is estimated to be about 8.0 inches. (Other acceptable references for computing the PMP in other areas of the Western United States are listed in Ref. 10.)*** Using Reference 10 (see Note 4), the 5-minute PMP is calculated to be 25 percent of the 1-hour PMP or

$$\text{5-min PMP} = 0.25 \times 8 = 2.0 \text{ in.}$$

The rainfall intensity, i, in inches/hr is therefore

$$i = 2 \times \frac{60}{5} = 24 \text{ inches/hr}$$

** It is our understanding that NRC no longer recommends using Design of Small Dams for estimating precipitation.

*** Ref. 10 is outdated.

4. Determine Peak Flow Rate

Using the rational formula (Ref. 9) and using a runoff coefficient C of 1.0 because of the high intensity of the rainfall [and probability of nearly saturated antecedent soil moisture conditions], the peak runoff rate Q_i for a 1-foot-wide area is calculated by

$$Q_i = C\ i\ A$$

$$Q_i = (1)(24)\ \frac{300\ f^2 \text{ [ft.]}}{43{,}560\ f^2/\text{acre}}$$

$Q_i = 0.165$ cfs/ft

For a flow concentration factor of 5 *See Comment on pg. 11.

$Q_i = (5)(0.165) = 0.83$ cfs/ft

Step 2 - Compute Sheet Flow Velocity for Soil Cover

Using Manning's formula and a ~~simplified rectangular cross section with a width of 10 feet (see Note 5):~~ unit width approach:

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2} \quad \text{where}$$

Area = A = ~~10~~y for a ~~10-foot-wide rectangular~~ unit width section, (o.k.) where
y = depth of flow

Hydraulic Radius = R ≅ y since width is much greater than depth of flow

Bottom Slope = S = $^1/_5$ = 0.2

Manning's n = 0.025 for a cross section in earth (see Note 6) ** See comment on Note 6.

Unit Discharge = ~~Q~~ q = ~~(10)~~ ($~~Q_i~~$ q_i) = ~~8.3~~ 0.83 ft³/sec

$$0.83 = \frac{1.486}{.025} (y)(y)^{2/3} (0.2)^{1/2}$$

Solving for y,

y = 0.12 ft.

~~Therefore, Area = A = (10)(0.12) = 1.2 ft²~~

Velocity = V = ~~Q/A~~ q/y = .83/.12 = 6.9 ft/sec

The computed velocity of 6.9 ft/sec is greater than the allowable velocity of 4 ft/sec. Therefore, it must be concluded that the soil cover will be eroded, gullies will form, and a riprap layer will be required.

Step 3 - Design Riprap Layer

1. Compute Shear Stress

Using Manning's formula with an 'n' value of 0.04 for an assumed rock flow area (see Note 6) and the other parameters as above:

$$8.3 = \frac{1.486}{0.04}(10y)(y)^{2/3}(0.2)^{1/2}$$ (See Step 2 above.)* See comments in step 2.

$y = 0.16$ ft.

$A = 1.6 \text{ ft}^2$

$V = 8.3/1.6 = 5.2$ ft/sec

The shear stress (τ) may be computed by

$\tau = \gamma RS$ - Reference 11 (See Note 7.)

$\tau = (62.4)(0.16)(0.2)$ since $R \cong y$

$\tau = 2.0 \text{ lb/ft}^2$

A safety factor of about 1.5 ** See second comment on Pg. 9. should be included in the design (see Note 8). Therefore, the design shear stress is equal to

$\tau_o = (1.5)(2.0) = 3.0 \text{ lb/ft}^2$

The D_{50} riprap size required to resist this shear stress may be computed using page 41 of Reference 7.** For rock with a ~~specific~~ unit weight of 165 lb/ft^3,

**Why not use Safety Factors method?

Allowable $\tau_o = (0.04)(165 - 62.4)(D_{50}) = 4.1\ D_{50}$

Required $D_{50} = 3.0/4.1 = 0.7$ ft.

Therefore, a riprap layer with ~~an average~~ minimum D_{50} size of about 8 to 9 inches is needed to protect the face of the embankment.

The thickness and gradation of the riprap layer may be determined from Reference 12, depending on the size of rock available. In this case, if a gradation is selected where the layer thickness is equal to $1.5 \times D_{50}$, the required layer thickness is approximately 1 foot.

Step 4 - Determine Stable (Ungullied) Slope

1. Using the ~~qualitative~~ procedures outlined in Reference 1, ~~a stable (ungullied)~~ the steepest slope which will remain ungullied may be determined for a given region and the size of the drainage area.* Ref. 1, Fig. 3.4 gives slope-width ratios not resulting in gullies for pediments in the Chalk Bluffs area of N.E. Colorado, but not for other areas.
2. Using the procedures outlined in Steps 1 and 2 above, a slope that limits the velocity to the maximum permissible velocity may be directly calculated. In the example presented above, using the same input parameters to Manning's formula and solving for the slope, the stable slope S_s is

   $S_s \cong 0.04$ or about 1V on 5H * 0.04 ⇒ 1V on 25H, not 1V on 5H.

The above methods may be used to estimate the final stable slope after a long period of time and should represent an upper limit of slope recession and gully potential. In the event that the two estimates vary considerably because of particular soil conditions, regional peculiarities, or lack of data, chang - to model input parameters may be necessary to reflect more realistic conditions.

General Notes and Considerations on Appendix A Design Procedures

1. References 7 and 11 may be used to estimate maximum permissible velocities of soils.

2. A flow concentration factor of four to five times the normal sheet flow is based on literature reviews and examination of gully and rill patterns (Refs. 1 and 13) and provides a conservative representation of the contributing drainage area.* If the top of the pile contributes runoff down the slopes, this additional drainage area should be included to determine the runoff over the side slopes. (Modifications to the computation of time of concentration, rainfall intensity, and rainfall distribution may be necessary to reflect the runoff contribution from the additional drainage area.)
*See Note on Pg. 11. ~~(First Note)~~.

3. A time of concentration of 5 minutes when the actual tc is less than 5 minutes was selected for convenience. Using a tc of less than 5 minutes would increase rainfall intensity. In addition, the flow velocity down the slope is likely to be greater than 2 ft/sec. These factors may help to balance some of those design assumptions that may be overly conservative.
*See Note on Pg. 12 (First note).

4. Use of Reference 10 to compute rainfall distribution may not be as conservative as some other methods such as those in Reference 9. This too may help to balance any overly conservative assumptions.** See Notes 2 & 3 on Page 12.

5. ~~A rectangular 10-foot section was selected for ease of computation; in fact, the velocity can be directly computed by rearranging Manning's formula for~~ any width if R is assumed to be approximately equal to y.

6. Values of 'n' of 0.025 for earth and 0.04 for rock were selected based on general recommendations given in Reference 11. The range of 'n' values for shallow flows over rock layers may be somewhat higher than the 'n' values assumed here. However, the NRC staff believes that a high Manning's 'n' value may not produce a velocity that properly accounts for turbulence and increased shear stresses as a result of that turbulence.*** Reference 7 provides guidance for direct computation of 'n' values based on velocity,
*** For the safety factors method increasing "n" increases shear stress.

depth of flow, and roughness factors and may be used in calculating more precise 'n' values.

7. The shear stress may be calculated using Reference 6 or Reference 11. For simplicity, no corrections need to be made for side slope effects on shear stress for slopes that are 1V on 5H or flatter.

8. The NRC staff concludes that a safety factor should be included in the design of a riprap layer. This safety factor is needed to account for turbulence, nonuniform flow, and possible errors in hydraulic computational techniques in this range of flow. A safety factor of 1.5 is normally used by other government agencies in designing projects that have short design lifetimes.* For projects to remain stable for hundreds of years, the design goal should be that little or no damage occurs to an engineered design in the event of major rainfall or floods. It should also be pointed out that high sheet flow velocities can be produced by much less intense rainfall events because of the steep slopes of the reclaimed piles. If less conservative safety factors are used, they will be considered on a case-by-case basis depending on the degree of conservatism present in the other calculations.

9. The above analytical procedure may also be used to determine the need for rock protection for the top of a reclaimed pile.

*See Second Comment on Pg. 9.

** How about erosion protection for ditches?

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DRAFT VALUE/IMPACT STATEMENT

Not reviewed.

1. PROPOSED ACTION

1.1 Description

The proposed action is to provide engineering practices, design criteria, and analytical procedures that are considered to be satisfactory by the NRC staff for the design and construction of erosion protection systems for stabilized uranium mill tailing sites.

1.2 Need for Proposed Action

The milling and processing of uranium ores produce large volumes of liquid and solid wastes that are normally stored in man-made retention structures. When milling operations cease, the tailing disposal sites are stabilized in order to prevent the release of radiotoxic materials to the environment. It is therefore important to protect these sites from erosion due to floods, precipitation runoff, wind, or other natural phenomena.

1.3 Value/Impact of Proposed Action

1.3.1 NRC Operations

Consistent and satisfactory engineering practices used in the design and construction of erosion protection systems, as provided by the proposed guidance, will be beneficial to NRC license reviewers and will help NRC inspectors verify licensee adherence to requirements and commitments. This proposed action identifies acceptable methods for providing long-term erosion protection to meet the specific requirements of 40 CFR Part 192. These methods will facilitate licensing of uranium mills and of Uranium Mill Tailings Radiation Control Act (UMTRCA) program sites and will help NRC verify that uranium mill tailing disposal sites will not pose a threat to public health and safety, in accordance with the requirements of 10 CFR Part, 40 "Domestic Licensing of Source Material."

1.3.2 Other Government Agencies

The proposed action provides guidance to the Department of Energy, currently responsible for mill tailing management under 40 CFR Part 192. The value to other governmental agencies, including State and local governments, will be reflected in their comments on the guidance developed as it relates to their programs. The guide may be of value to the Agreement States by providing guidance by which State and local governments may develop their own particular criteria.

1.3.3 Industry

The recommended methods for the design and construction of long-term erosion protection have been developed using the best available technology and engineering practices and considering the degree of erosion protection necessary, the time period over which the system must protect the tailings, the materials available, and the cost to industry. The proposed action would enable industry to adequately protect mill tailing disposal sites from erosion and in many cases would reduce the need for extensive long-term maintenance. The proposed action may result in additional cost to the industry in the near-term but may reduce long-term operational maintenance costs. No overall negative impacts to the industry are expected as a result of the proposed action.

1.3.4 Public

The proposed guidance would provide reasonable assurance that the public would not be subject to significant risk from the disposal of uranium mill tailings, in accordance with the requirements of 40 CFR Part 192.

1.4 Decision on Proposed Action

The proposed action should be accomplished because of the aforementioned benefits.

2. TECHNICAL APPROACH

2.1 Technical Alternatives

The action will provide satisfactory and consistent engineering practice for the design and construction of erosion-protection systems. Alternative approaches will be reviewed by the NRC staff on a case-by-case basis. Public comments may indicate equally acceptable technical alternatives.

3. PROCEDURAL APPROACH

3.1 Procedural Alternatives

Methods that have been considered for providing necessary guidance include the following alternatives:

- Amendment to the regulations
- NUREG-series report
- Branch position
- Regulatory guide

3.2 Discussion of Procedural Alternatives

At this time, an amendment to the regulations or the issuance of a NUREG-series report is not practical for use by NRC reviewers, licensees, and applicants.

At the present time, there is no branch position to provide interim guidance until the proposed regulatory guide is developed.

3.3 Decision on Procedural Approach

The development and issuance of a regulatory guide for public comment would best fulfill the need for the proposed action.

4. STATUTORY CONSIDERATIONS

4.1 NRC Regulatory Authority

Authority for this regulatory guide is derived directly from the safety requirements of the Uranium Mill Tailings Radiation Control Act of 1978, which amended the Atomic Energy Act of 1954. This guide helps fulfill the requirements of 10 CFR Part 40, "Domestic Licensing of Source Material," and, in particular, the requirements of the National Environmental Policy Act of 1969 as given in 10 CFR Part 51, "Licensing and Regulatory Policy and Procedures for Environmenal Protection." This proposed guide also will be used to evaluate compliance with the EPA's proposed 40 CFR Part 192, "Environmental Protection Standards for Uranium Mill Tailings," which regulates the cleanup of open lands and buildings contaminated with residual radioactive materials at inactive uranium processing sites.

4.2 Need for NEPA Statement

Issuance or amendment of guides for the implementation of regulations in Title 10, Chapter I, of the Code of Federal Regulations is a categorical exclusion under paragraph 51.22(c)(16) of 10 CFR Part 51. Thus, an environmental impact statement or assessment is not required for this action.

5. RELATIONSHIP TO OTHER EXISTING OR PROPOSED REGULATIONS OR POLICIES

5.1 Relationship with Regulations or Policies of Other Government Agencies

No potential conflicts with other governmental agencies have been identified. However, Agreement States under Section 274 of the Atomic Energy Act of 1954, as amended, must consider the guide when developing decommissioning plans and protection for long-term erosion for uranium mill tailings. Non-Agreement States that regulate the reclamation of uranium mill tailings may also follow the provision set forth in this guide. In addition, this guide will provide criteria for the implementation of 40 CFR Part 192.

5.2 Relationship with Other NRC Regulations and Policies

The proposed regulatory guide is intended to be used in conjunction with the following NRC documents to the extent that the following documents affect the erosion protection of stabilized uranium mill tailings:

a. Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills."

b. Regulatory Guide 3.11.1, "Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings."

c. Regulatory Guide 3.5, "Standard Format and Content of License Applications for Uranium Mills."

d. "Final Generic Environmental Impact Statement on Uranium Milling," NUREG-0706, 1980.

6. CONCLUSIONS

The NRC has both the need for and the authority to implement the proposed action. The development of a regulatory guide is the most favored procedural alternative.