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TECHNOLOGY DEPARTMENT
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Mr. Ross A. Scarano
Uranium Recovery Licensing Branch
Division of Waste Management
Nuclear Regulatory Commission
Washington, DC 20555

Subject: Comments re Draft of "Hydrologic Design Criteria for Tailings"

Dear Mr. Scarano:

Attached is our response to the NRC Staff Technical Position Paper WM-8201 on Hydrologic Design Criteria for Tailings.

Sorry for the late response and hope that our comments will provide additional information for review.

Very truly yours,

R. Brown

R. Brown

RB:ly
Attach.

cc: RGB; JFF; ACJ; TJK; PCR
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RESPONSE TO NRC STAFF
TECHNICAL POSITION WM-8201

HYDROLOGIC DESIGN CRITERIA
FOR TAILINGS RETENTION SYSTEM

General Remarks

The concept of Probable Maximum Precipitation (PMP) and its progeny the Probable Maximum Flood (PMF) originated during the civil works programs of the late 1930s. During this time there were two driving forces: (1) planning and construction of numerous water related projects and (2) a need for flood flow estimates when hydrologic records were scarce. The objective of the PMF method is to provide a design standard for flood control works, the failure of which would lead to catastrophic loss of life and property.

The PMF method treats a random hydrologic phenomenon as a deterministic process. Calculations for the PMF yield a discharge which purportedly is characteristic of the flood expected from "the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region" (1).

This approach, however, suffers from at least three major disadvantages:

(1) it is entirely subjective.

(2) there can be no meaningful economic evaluation (2).

(3) there is no associated probability level (3).

To the public, a design based on the PMF often implies that the risk of flooding is eliminated. This, of course, is not true for there is absolutely no evidence to support the notion of an extreme boundary on the meteorological factors which produce floods. The PMF and other such imaginary events, therefore, represent arbitrary limits.

Any policy which advocates use of the PMF reflects a rather myopic viewpoint -- one that tends to ignore the inevitable consequences of the aftermath following any flood which might approach the PMF. Considering the magnitude and the extent of devastation expected to accompany a PMF, the incremental impact which results from rinsing out a tailings impoundment is not likely to be measurable or even perceptible after the high water recedes. It would appear, therefore, that continued use of the PMF policy simply promotes expediency at the expense of truth.

(Note: numbers underlined in parentheses refer to references)

For most projects today, sufficient hydrologic data are available to perform a thorough and representative flood study. Classical flood frequency techniques or stochastic time series analysis using actual historical information are preferable to the PMF method.

Comments on NRC Staff Position

There is at least one encouraging note in the NRC staff position. For impoundment storage capacity, the new guidelines in some cases may provide appreciable reductions in the surcharge requirement. One option for surchage capacity considers storing "the runoff from ½ of the 6-hour local PMP with three feet of freeboard for wind wave activity" (4). According to the Corps of Engineers, this runoff volume (½ PMP) should correspond roughly with the volume expected from a Standard Project Flood (SPF):

> ... estimates completed to date indicate that SPF discharges based on detailed studies usually equal 40 to 60 percent of the maximum probable (or "maximum possible") (sic) flood for the same basin; a ratio of 50 percent is considered representative of average conditions. (5)

The SPF is a blood relative of the imaginary PMF. Like the PMF, the SPF has no defined probability level. Nevertheless, storage requirements based on the SPF do represent a relaxation of the previous NRC regulations which mandated use of the PMF series.*

For diversion channels, however, the NRC has proposed stringent guidelines where previously no clearly defined policy existed. The guidelines provide the apparent latitude of allowing the licensee to select the design discharge for a diversion channel. However, because the channel must pass the PMF without the release of tailings, the PMF will ultimately dictate design of the channel.

Comparison to Traditional Engineering

The present NRC staff position (WM-8201) represents the extreme case of the "traditional approach" to hydrologic engineering. Under the traditional approach, an arbitrary design standard is selected for a particular project. Often the level of design is commensurate with

*The PMF series consists of the Probable Maximum Flood and a flood equivalent to 40% of the PMF occurring 3-5 days before the main flood. (1)

the importance and the longevity of a project. For example, at an urban development with a project life of 20 years, storm sewers may be sized to convey the 5-year rainfall runoff event; at a large municipal reservoir with a project life of 100 years, the emergency spillway may be sized to pass the 500-year flood.

Although rarely evaluated, there is an implicit finite probability or "risk" that the design discharge will be exceeded at least once during the project life. For the examples mentioned above, this risk is:

Storm Sewer	98.8%
Emergency Spillway	18.1%

It is important to note that this risk is not necessarily the chance of (structural) failure. Rather it reflects only the likelihood that a flood will exceed the design discharge during the project life. The point here is that with the traditional engineering approach, once the project life and the design standard are determined, the level of risk is automatically specified.

It would appear more rational to first specify the acceptable risk or the desired level of performance for each project and then to determine the corresponding design standard or discharge.

In a crude sense, the PMF policy advocated by the NRC attempts to do just this by implying that the acceptable risk is 0.0 percent. However, as mentioned previously, the PMF is a misconception which provides only a false sense of absolute security (6).

It should be recognized that specifying an acceptable level of risk for an engineering project would not necessarily guarantee the optimum design. Although the risk approach would acknowledge that all engineering projects must "play the odds", selection of the acceptable odds would remain an arbitrary decision.

Recommended Procedure for Hydrologic Design

There is a more objective approach to hydrologic engineering design. This approach, known as "economic risk analysis", will identify the particular design alternative which satisfies project requirements at the least total expected cost.

In economic risk analysis, the total cost (construction, operation/maintenance) of a particular design alternative is evaluated on the basis of its performance over the entire range of flood flows which may occur at the project site. The key step is integration of operation and maintenance costs with respect to the annual probability of flood flows as defined by the site specific flood frequency relationship. This step translates operation/maintenance expenses into an expected annual cost. The analysis is repeated for a number of design alternatives all of which would satisfy project requirements. The optimum design is that which minimizes the total expected project cost.

This approach provides a solution to the classic problem of optimizing the trade off between capital costs and operation/maintenance expenses. In economic risk analysis, the total costs reflect expenses of both the licensee and the community.

The Federal Highway Administration of the U.S. Department of Transportation has several publications describing application of economic risk analysis to design of river crossings and other flood plan encroachments (7, 8). The analytical framework is established and the procedure is well-documented. This method of analysis should be extended by the NRC to include hydrologic design criteria for tailings impoundments and diversion channels.

A switch to economic risk analysis would be a significant improvement over the present PMF policy.

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Comments on NRC Draft Staff Technical Position WM-8201, Uranium Recovery Licensing Branch, Hydrological Design Criteria For Tailings Retention Systems

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2.A.1. "...if a flood should occur, operational measures are available to lower the water level of the impoundment."

What are specific implications for operational monitoring?

5.A.1. "...(1) the entire runoff from an occurrence of the 6-hour local Probable Maximum Precipitation (PMP), with one foot of freeboard."

Reference 7 recommends that PMP calculations consider both a local-storm PMP and a general-storm PMP. The NRC technical position (WM-8201) does not mention the general-storm PMP. Is this event to be disregarded in the precipitation analysis?

6.A.2. A table of incremental PMP rainfall amounts is presented in the NRC text.

Does the tabulated distribution of PMP rainfall amounts apply to other rainfall events, all of which would by definition be less than the PMP?

General Remark:

The NRC regulatory guide 3.11 requires use of the "probable maximum flood" series as part of basic design criteria for surcharge capacity of a retention system. The NRC technical position (WM-8201) now requires use of 6-hour local PMP for storage capacity design. Is the PMF series to be replaced by the local PMP event? If not, what is the recommended duration of 100-year flood used in PMF series?