Item B-31: Dam Failure Model (Rev. 1)

DESCRIPTION

Historical Background

This issue, as originally stated in 1978,[1] addressed the unavailability (at that time) of a suitable model to predict the erosion rates and, therefore, the flood hydrographs at nuclear power plant sites resulting from the gradual failure of earthen embankment dams. In the absence of such an analytical model, the NRC staff was forced to postulate the instantaneous and complete failure of dams as the basis for flood hydrograph prediction.

The original proposed resolution of this issue was for the staff to develop a model and to validate it using existing dam failure data. This model, when developed, would provide a consistent approach to the required analyses at all riverine sites and would potentially reduce staff time dedicated to the development and review of analytical

methods for individual plant sites.[2]

Since this issue was raised, significant progress has been made in the development and validation of models for gradual failures of earthen dams (References 1124, 1125, 1126, 1127, 1128). Several models have been developed, coded, and the results compared against actual dam failure data. In addition, a 1983 study sponsored by the NRC applied available models to the assessment of flood risk at the Haddam Neck plant. The results of the Haddam Neck study indicated that such models can be used judiciously to guide design on

regulatory decisions.[3]

Safety Significance

Analysis prepared by PNL[4] indicates no direct safety significance associated with this issue; instead, it involves the development and application of a standardized analytical methodology to an element of the licensing process.

Possible Solution

The proposed resolution to this issue, as originally stated in 1978, was for the NRC to proceed with development of an analytical model, or nomograph, to predict erosion rates and patterns of failure for an earthen embankment

for a given initiating mode.[5] Since that time, the state-of-the-art for modeling of the gradual failure of earthen dams has advanced considerably. Efforts undertaken in the late 1970s and early 1980s by the National Weather Service (NWS), the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC), the Soil Conservation Service (SCS), and others have resulted in the availability of several well-documented computer models. In particular, the NWS-DAMBRK and the HEC-1 Dam Safety Models have been evaluated against actual flood hydrographs in recent studies and both have been used to analyze the flooding risks at a nuclear power plant site. Results of these and other studies indicate that the NWS-

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[1] NUREG-0471, "Generic Task Problem Descriptions (Categories B, C, and D)," U.S. Nuclear Regulatory Commission, June 1978.
[2] Dam Failure Model, Pacific Northwest Laboratories, October 1983.
[3] "Use of A Dam Break Model to Assess Flooding at Haddam Neck Nuclear Power Plant," Water Resources Bulletin, Vol. 20, No. 6, American Water Resources Association, December 1984.
[4] Dam Failure Model, Pacific Northwest Laboratories, October 1983.
[5] NUREG-0471, "Generic Task Problem Descriptions (Categories B, C, and D)," U.S. Nuclear Regulatory Commission, June 1978.

DAMBRK model, at least at present, outperforms other models in the simulation of downstream flood profiles.

The resolution of this issue, therefore, remains only for the NRC to assess and apply the available models, including recent progress in two-dimensional solutions, to the classical St. Venant equations (other models are based on one-dimensional solutions) and to assure that the selected model or models are optimal for NRC applications.

CONCLUSION

Public and occupational risks are not expected to be affected by resolution of this issue. The proposed resolution was for the NRC to proceed with development and validation of a suitable dam break model. As documented

above, models are available so that the NRC development cost originally estimated by PNL[6] to be $18,200 is eliminated. Generic endorsement of an existing model, for instance DAMBRK, is estimated to pose a potential for a very modest combined savings to the NRC and the industry (~$50,000 total), primarily because of the very limited number of plants, perhaps 4 or 5, which might desire to use the model in their licensing evaluation.

The primary significance of this issue is in the review of power plant construction requirements that takes place during the plant construction phase (construction permit and pre-operating license review). Existing plants may require preparation of updated flood protection analyses. This would occur especially in cases where new dams or other water impoundments which may affect existing plants have been created since the original licensing of these plants. Also, some early plants may not have sophisticated flood protection design analyses, so review and updating of flood hazards may be appropriate. Therefore, although presently not of major significance, this issue could become more important in the context of license renewals.

This issue addresses the analytical methodology for determining plant site flooding potential and improving the effectiveness of the review of license applications; it does not address the occurrence or frequency of specific safety-related plant events. Therefore, it is considered to be a Licensing Issue. Based on the fact that adequate models have been developed to analyze earthen dam failures, it is recommended that this issue be dropped from further consideration.

[6] NUREG/CR-2800, "Guidelines for Nuclear Power Plant Safety Issue Prioritization Information Development," U.S. Nuclear Regulatory Commission, February 1983, (Supplement 1) May 1983, (Supplement 2) December 1983, (Supplement 3) September 1985, (Supplement 4) July 1986, (Supplement 5) July 1996.