NRR-PMDAPEm Resource

From: Kuntz, Robert
Sent: Monday, September 15, 2014 2:52 PM
To: David.Haile@duke-energy.com
Cc: Hall, Randy; Whaley, Sheena
Subject: Request for Additional Informaiton - Oconee Flooding Hazard Reevaluation Report (TAC NOS. MF1012, MF1013, AND MF1014)
Attachments: Oconee RAI on XuZhang.docx

Mr. Haile,

By a letter dated March 12, 2013, Duke Energy submitted its flood hazard reevaluation report (FHRR) for Oconee Nuclear Station (ONS), Units 1, 2, and 3 (ADAMS Accession Number: ML13079A227).

Based on a review of the submittal, the NRC staff has determined that the attached request for additional information (RAI) is required in order to complete its review. As we discussed in our clarification call, the NRC staff requests that Duke provide a response, or a schedule to provide a response, within 30 days of this email. The NRC staff has determined that no security-related or proprietary information is contained herein.

Sincerely,

Robert Kuntz
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NRR/JLD/JHMB
(301) 415-3733

Hearing Identifier: NRR_PMDA
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Request for Additional Information
Fukushima Lessons Learned Flood Hazard Reevaluation Report
Oconee Nuclear Generating Station Units 1, 2, and 3
(TAC NOS. MF1012, MF1013, AND MF1014)

Failure of Dams and Onsite Water Control/Storage Structures (Choice of Methodology and Technical Rationale - Dam Breach Parameters Estimation)

Background and Discussion

By a letter dated March 12, 2013, Duke Energy submitted its flood hazard reevaluation report (FHRR) for Oconee Nuclear Station (ONS), Units 1, 2, and 3 (ADAMS Accession Number: ML13079A227).

The flood hazard reevaluation report contains dam breach analyses performed using the dam breach parameter estimation methodology proposed by Xu and Zhang[1]. Initial review of the breach methodology by the staff resulted in the following observations:

- The methodology has not been applied for use in past hazard assessments related to the siting of new nuclear facilities by NRC staff.
- The methodology relies on highly subjective erodibility criteria with no clear ties to soil engineering and hydraulic properties, and moreover, the erodibility classes were inferred in many instances by indirect methods.
- The database used in the development of the equations by Xu and Zhang uses information from sites in China with minimal verifiability and assumptions about the prevailing conditions that are necessary to deduce information on erodibility.
- The methodology appears to have a different implementation of the dam breach time parameter as compared to other methodologies.
- The parameters used to determine failure time do not appear to be suitable to use as the breach formation time parameter in the hydraulic model HEC-RAS, which is a widely used modeling environment and the one selected for use in the Oconee FHRR.

The U.S. Nuclear Regulatory Commission (USNRC) subsequently commissioned a study to determine the suitability of the Xu and Zhang methodology. The study was conducted by Mr. Tony Wahl, P.E., of the U.S. Bureau of Reclamation (USBR). He is the author of the 1998 report on breach parameter estimation[2] with over a decade of collaboration with developers modeling software such as WinDAM and HR-BREACH. The study was peer reviewed by some of the leading experts in this technical area.

The details of the USBR study are published in the report "Evaluation of Erodibility-Based Embankment Dam Breach Equations" (Hydraulic Laboratory Report HL-2014-02 June, 2014)[3].

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[1] Xu, Y. and L.M. Zhang, 2009. Breaching parameters for earth and rockfill dams. Journal of Geotechnical and Geoenvironmental Engineering, 135(12):1957-1970.

[2] Wahl, T.L., 1998. Prediction of embankment dam breach parameters: a literature review and needs assessment, Dam Safety Research Report DSO-98-004, U.S. Dept. of the Interior, Bureau of Reclamation, Denver, Colorado, July 1998.

[3] The report is published online at http://www.usbr.gov/pmts/hydraulics_lab/pubs/HL/HL-2014-02.pdf

Key findings of the study are as follows:

- The evaluation showed that the Xu and Zhang breach height, breach width, and peak outflow equations produced reasonable predictions of observed breach parameters for medium- and high-erodibility dams.
- Despite the necessarily subjective manner in which erodibility classifications were assigned to the case study dams, erodibility classification is a valuable input parameter.
- The failure times predicted by the Xu and Zhang equations (both 'best' and 'best simple') were consistently and significantly longer than observed breach formation times. Xu and Zhang's mixture of failure times does not represent a single parameter but is instead an ill-defined combination of different times. This negates the value of their failure time equation for most practical purposes, since one cannot know reliably what it represents. Therefore, the Xu and Zhang failure time equation cannot be applied with confidence because it is based on data that represents an undefined mix of breach formation times and total breach times
- For breach outflow hydrograph modeling, the times are too long and will yield unrealistically low estimates of peak breach outflow. The equation is also not useful for predicting breach initiation time, since it represents something approaching total failure time, and there is no way to separate out only the breach initiation time.
- For predicting the breach formation time to be used as input to a parametric dam failure model, other existing equations should be utilized, such as Froehlich[4], Von Thun and Gillette[5], or others.
- It was impossible to effectively test the Xu and Zhang equations for dams with low erodibility. Only seven dams in this category were present in the original data set, and four of these were cases from China which there was no English-language supporting documentation. Of the 3 remaining cases, examination of supporting documents revealed that Winston Dam was composed of very weak soils and had an uncertain observed failure time, Frankfurt Dam was of unknown composition (only described as "earthfill") with an uncertain failure time, and Oros Dam was low-erodibility but had an unreliable observed peak outflow. With such limited data, the low-erodibility adjustment factors presented in Xu and Zhang equations cannot be verified.
- With regard to rockfill dams, failure times were overpredicted for all five cases and medium-erodibility appears reasonable for rockfill dams.

In addition to the FHRR, the staff reviewed a report submitted by Duke Energy on the validation of the dam breach methodology developed by Xu and Zhang, titled "Validation of HRR Breach Hydrograph for Jocassee Dam" by Mr. Joseph L. Ehasz, P.E., and Dr. David S. Bowles. This report reviews the suitability of the dam breach parameters for Jocassee Dam and discusses the suitability of the Xu and Zhang regression equation for use as input to HEC-RAS and SRH-2D computer models. Since the Jocassee Dam is regulated by the Federal Energy Regulation Commission (FERC), NRC requested that FERC review the Ehasz and Bowles report. By a letter dated August 14, 2014, FERC responded to NRC's request via a technical memo. The FERC memo stated that the Xu and Zhang regression equations do not have an adequate dataset to apply the methodology to large, rockfill structures with substantial reservoir volumes

[4] Froehlich, David C. (2008), "Embankment Breach Parameters and Their Uncertainties", Journal of Hydraulic Engineering, 134(12), pp. 1708-1721.
[5] Von Thun, J. L., and Gillette, D. R. (1990), Guidance on Breach Parameters unpublished internal memorandum, U.S. Department of Interior, Bureau of Reclamation. Denver, Colorado.

such as the Jocassee Dam. The FERC memo also affirmed NRC's determination by concluding that relying on the Xu and Zhang equations alone for determining breach parameters at Jocassee Dam is not appropriate.

Information Requested

Based on the findings of the USBR study commissioned by the NRC and independent conclusions reached by FERC, the Xu and Zhang equations are not appropriate as applied in the submitted FHRR by Duke Energy. In particular, the USBR study and FERC memo conclude that there is inadequate data on low-erodibility dams to support the Xu and Zhang equations for the low-erodibility category. In addition, the Xu and Zhang equations for dam failure time cannot be reliably applied for the purposes of breach hydrograph prediction since the predicted times do not represent the HEC-RAS breach formation time. Instead, results produced using the Xu and Zhang equations represent an uncertain mix of breach initiation and breach formation times.

The staff requests that Duke Energy reanalyze and resubmit the dam failure analyses for the ONS, Units 1, 2 and 3 FHRR after applying alternate breach-parameter estimations than those predicted using the Xu and Zhang methodology. Because of the large uncertainties, inconsistencies, and potential biases associated with breach modeling in general, the staff requests that the model results not rely on a single methodology. Instead, the staff requests comparison of results for several models judged appropriate (although the Oconee FHRR was submitted before JLD-ISG-2013-1 (ML13151A153) which was completed in July, 2013, this JLD-ISG may provide useful guidance regarding application of breach models the NRC staff find appropriate for use). Justification should be provided for the selection of the candidate breach models used as well as the selected value(s) used in the hydraulic model. Parameter uncertainty as well as parameter sensitivity in the final model results should be explicitly addressed in the response.