UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

OFFICE OF THE
SECRETARY

November 12, 2015

NOTICE TO THE PARTIES IN: NUCLEAR INNOVATION NORTH AMERICA, LLC (SOUTH TEXAS PROJECT, UNITS 3 AND 4)

SUBJECT: RECEIPT OF COMMUNICATION REGARDING SOUTH TEXAS COMBINED LICENSE APPLICATION

The Commission has received the attached statement of concern regarding the design basis flood level for the South Texas Project, Units 3 and 4, combined license application. This information is being served on the parties to the proceeding for their information.

/RA/
Emile L. Julian
Assistant for Rulemakings
and Adjudications

CC: South Texas COL Service List

Docket, Hearing

Subject: Communication Under the Open Door Policy - SECY 15-0123, STP COLA Hearing Scheduled on November 19, 2015

Attachments: OpenDoorPolicy-Commissioners-11022015.pdf

From: "Ahn, Hosung" <Hosung.Ahn@nrc.gov>
Subject: Communication Under the Open Door Policy - SECY 15-0123, STP COLA Hearing Scheduled on November 19, 2015
Date: 02 November 2015 16:34
To: "Burns, Stephen" <Stephen.Burns@nrc.gov>, "Svinicki, Kristine" <Kristine.Svinicki@nrc.gov>, "Ostendorff, William" <William.Ostendorff@nrc.gov>, "Baran, Jeff" <Jeff.Baran@nrc.gov>

Dear Chairman and Commissioners,

With this email, I would like to raise technical concerns related to determining the design basis flood level for the South Texas Project (STP) Units 3 and 4 Combined License Application (COLA). I am a hydrologist with the Division of Siting and Environmental Analysis in NRO, and was a lead reviewer for the Chapter 2.4 (Hydrology) in the STP COLA from 2007 to 2011 or till I filed a non-concurrence.

I assert that the flood analysis for a postulated breach of the Main Cooling Reservoir (MCR) embankment dyke is neither accurate nor conservative (refer to the attached document). This results in an underestimation of the design basis flood level which is one of the key site parameters for structural designs, flood protection, and probabilistic risk assessments. My re-analysis attached to the non-concurrence package demonstrates that the design basis flood level could be approximately 5 feet higher than the licensee's estimation. As this change would be significant, I recommend revising the design basis flood parameter.

Please feel free to contact me if you have any questions/clarifications on the raised concerns. I am looking forward to have your response after reviewing the concerns.

Sincerely Yours,

Hosung Ahn, Ph. D., P.E.
Hydrologist
NRO/DSEA/RHM1
301-415-1398

Technical Concerns Regarding the Uncontested Hearing for Issuance of Combined Licenses for the South Texas Project Units 3 and 4, SECY 15-0123

Prepared by **Hosung Ahn**, Hydrologist, NRO/DSEA/RHMB, November 2, 2015

Executive Summary

The purpose of this document is to raise technical concerns related to determining the design basis flood level for the South Texas Project (STP, the licensee) Units 3 and 4 Combined License Application. I assert that the flood analysis for a postulated breach of the Main Cooling Reservoir (MCR) embankment dyke is neither accurate nor conservative. This results in an underestimation of the design basis flood level which is one of the key site parameters for structural designs, flood protection, and probabilistic risk assessments. My re-analysis attached to the non-concurrence package demonstrates that the design basis flood level could be approximately 5 feet higher than the licensee's estimation. I recommend revising the design basis flood parameter.

Introduction

The key documents relevant to the raised concerns are: (1) SECY 15-0123 dated September 30th, 2015; (2) Licensee's Final Safety Analysis Report (FSAR) for STP Units 3 and 4, Subsection 2.4S.4.2.2, MCR Embankment Breach Analysis; (3) Staff's Final Safety Evaluation Report (FSER), Subsection 2.4S.4, Potential Dam Failure; and (4) the Non-concurrence Package (ML12348A249) filed in 2011 and concluded in 2012. The non-concurrence addressed three separate topical areas: embankment dike breach; hurricane storm surge; and maximum groundwater level. However, this document addresses only the first one which is the most critical.

MCR is an in-ground reservoir encircled by an earth embankment dike. After constructing the reservoir in 1983, STP performed filling tests up to the reservoir level of 45 ft above the mean sea level (msl) from 1983 to 1989. These tests were to evaluate the performance of the embankment and under-seepage control system. The tests resulted in adding over 100 relief wells to control seepage and hydrostatic pressure in the dike foundation. In the Combined License Application, STP proposed to raise the maximum reservoir operation level to 49 ft msl to provide enough cooling water to existing and new units. Raising the reservoir operation level provoked dike breach issues.

In general, piping (sunny day) failure of an earth dike is an episodic event which could happen anytime and anywhere. Therefore, the licensee considered a MCR dike piping failure as a plausible flood causing mechanism. They postulated initially a dike breach width of 4,757 ft in its FSAR Revisions 0 and 1, but reduced the breach width to 417 ft in the FSAR Revision 2 and thereafter. The reduced breach width is small compared to the other estimations. For example, the postulated breach widths for the same dike in the STP Units 1 and 2 FSAR and for the similar cooling pond dike described in the Victoria Early Site Permit are approximately 2000 ft.

Issues on the MCR Dike Breach Analysis

The licensee estimated the breach width of 417 ft based on an empirical best-fit (mean) regression equation developed by Froehlich in 1995. The Froehlich equation, which predicts breach width using reservoir storage volume and breach head as independent variables, has a large uncertainty due to an intrinsic variability of historic breach data. However, the licensee ignored the variability in determining the breach width. The upper bounds of the regression estimate would be almost 2.4 times larger than the mean estimate, indicating that the chance of exceeding the mean breach width would be about 50 per cent. This is as if one decides a mean earthquake magnitude of 5 as a design basis at a region where historical earthquake magnitudes range from 3 to 7. Professor Baecher of the University of Maryland, one of the three external peer reviewers of the non-concurrence, pointed out that the regression estimates ignore "significant statistical uncertainties." In my opinion, the licensee should use an upper bounding regression equation in order to account for the uncertainty in this case.

With the breach width of 417 ft, the licensee estimated a breach outflow hydrograph using the FLDWAV flow routing model and a corresponding site flood level of 40 ft msl using a hydrodynamic model. The licensee confirmed these estimates using a BREACH model simulation. BREACH, which was developed by the National Weather Service in 1991, has been recognized as a best available and physically-based numerical model to simulate the breach erosion and outflow processes simultaneously.

The NRC staff concluded based on a confirmatory BREACH sensitivity analysis and a review of similar historical breach data that the licensee's breach parameter estimation is reasonable and acceptable. I did not concur. Therefore, I filed a non-concurrence in 2011 to raise five technical issues related to the licensee's breach flood analyses and the staff review. Three external experts made a peer review of the documents related to the non-concurrence. The NRC management concluded in 2012 based mainly on the result of the peer review that the licensee's breach flood estimates are appropriate. I again disagreed with the management's conclusion. At this time, I am going to address the following two critical issues which are contrary to field data and the principle of hydrology.

A. The licensee and the staff ignored the effects of embankment foundation scouring.

Historical records show that about 36 percent of the earth embankment piping failures were due to foundation failure (USBR, "Internal Erosion - Dam Safety Risk Analysis Best Practices," 2010). In general, breach of an earth embankment often creates deep foundation scouring unless the foundation is reinforced with curtain walls or is consolidated by grouting. Dike breaches with foundation scouring have been modeled by many hydrologists as summarized in my non-concurrence. For example, the dike system for the Martin Cooling Pond in Florida was breached in 1979 with a breach width of approximately 600 ft and a maximum scouring depth of 29 ft, even though its breach formation factor (i.e., a product of reservoir storage volume and head) is only a third of the MCR one. However, both the licensee and the staff totally ignored the effects of foundation scouring in their breach analyses.

I re-emphasize that, if the MCR embankment dike breaches, the foundation scouring will be highly for the following reasons:

- The FSAR states that the MCR dike and its foundation were constructed with onsite clay soils excavated mostly from the inside of the MCR (Subsection 2.5.6.4.1.1). It also says that the foundation was treated by: (i) removing trees, stumps, and brush; (ii) scarifying the surface soil to a depth of 9 inches; and (iii) replacing weak soil with cohesive clay and then compacting it (Subsection 2.5.6.3.1). That is, the clay soil materials and construction (compaction) methods for the dike and foundation are nearly identical.

- The MCR dike and foundation were designed and constructed to maintain the stability of the structures. However, they were not designed to resist the erosion forces caused by a potential breach. Especially, the foundation was neither grouted nor consolidated to prevent piping and scouring.

- The FSAR (Tables 2.5.6-2 and 2.5.6-5) notes that the natural cohesive strength of the clay soils for the dike and foundation was very high (over 1000 pounds per square feet (lb/ft^2)) but the strength was reduced substantially (about 300 lb/ft^2) after the construction of and filling in the MCR due to the saturation of the clay soils. The BREACH model used this reduced strength value, but the peer reviewers failed to recognize it.

- The foundation has two separate natural sand layers through which significant seepage has been observed after filling water into the MCR. A total of 774 relief wells were installed during the construction of MCR and after the filling tests to control seepage and excess hydrostatic pressure in the sand layers. More relief wells may be needed to accommodate the proposed reservoir level raise which could increase pore pressure in the sand layers.

- The licensee proposed to use six groundwater pumping wells with a total pumping rate of 2,450 gallons per minute to meet the non-cooling water demand for both existing and new plant units. Four of these wells are close to the MCR embankment dike. The staff estimated in its Environmental Impact Statements Report (Section 5.2.2.2) that, under a conservative pumping scenario, a maximum drawdown of groundwater level in the aquifer near the wells could be about 33 ft. This significant drawdown could induce land subsidence that could in turn induce a piping failure in the dike and foundation.

The three external peer reviewers asserted that a scour hole will not form at the MCR embankment foundation without considering the above factors. Specifically, Professor Baecher and Mr. Patev asserted small breach width and/or no foundation scouring mainly due to high cohesive strength of clay soils. However, they failed to recognize a significant reduction of the strength of the clay soils as mentioned above. Also, they did not correctly interpret the outcome of the BREACH model.

The result of the MCR BREACH runs indicates that the breach flow velocities range from 10 feet per second (ft/s) to 40 ft/s (Figure 2 (bottom)). These velocities exceed significantly the critical erosion velocity of 10 ft/s (from the Hjulstrom Curve in Figure 2 (top)) for the given clay soils with a particle size of 0.001 millimeters as specified in the BREACH. The erosion process represented by the Hjulstrom curve developed in 1935 is old but intuitively simple. The theory of the hydrologic erosion process has been advanced substantially during the past 40 years as many accurate erosion equations are now available. The new erosion equation predict the erosion capacity based not only on soil particle size and flow velocity, but also on additional soil parameters such as cohesion coefficient, friction angle, bottom roughness, particle distribution, and critical share stress coefficients. The Smart Equation adopted in the BREACH model is one of them as it uses both breach flow and soil characteristics.

The licensee's and staff's MCR BREACH models specified the embankment soil properties correctly. However, they set up the input of the BREACH model so that the breach process occurs only on the dike but not on the foundation. This was done by specifying the breach starting level of 34 ft msl (mid-height) and the breach bottom of 29 ft msl. With this setting, a piping process in the BREACH expands from the starting point to all four directions (top, bottom, left, right), but the downward progression will stops artificially at the dike bottom without further progressing to the foundation. My re-analysis demonstrates that simply relaxing the breach bottom constraint induces the erosion process to the foundation by soil properties, resulting in increasing the breach outflow volume substantially. The modeling process and result were documented in the non-concurrence. However, the peer reviewers failed to recognize them.

B. The tailwater section specified in the breach model is too small to form a full breach.

The most critical parameter in the BREACH model is the bottom roughness coefficient (or so-called Manning's n-value) on the breach section. Higher n-value creates larger breach width and thus higher flood level. The licensee performed a BREACH sensitivity analysis with different n-values (0.025, 0.05, 0.08), from which they concluded that the breach peak flow results with n-value of 0.08 are lower than the peak flow obtained with the FLDWAV model (FSAR Subsection 2.4S.4.2.2.2.4.3).

The staff performed an independent sensitivity analysis using the licensee's BREACH model. They concluded that the BREACH simulation with an n-value of 0.075 yields a breach peak flow of 127,927 cubic feet per second (cfs) which is within the FLDWAV estimate of 130,100 cfs. Staff also concluded that the geometry of the tailwater section is not a limiting factor in breach growth (FSER page 2-141).

My re-analysis revealed that both licensee's and staff's above conclusions are inaccurate. Their sensitivity analyses were based on a fictitiously-drawn small tailwater cross section above the land surface (see Figure 1 (bottom)). This results in artificial constriction of the breach process in the model. That is, the fictitious tailwater channel induces a small breach head (i.e., the water level difference between MCR and tailwater section) by inadvertently increasing tailwater level during the early stage of a piping failure.

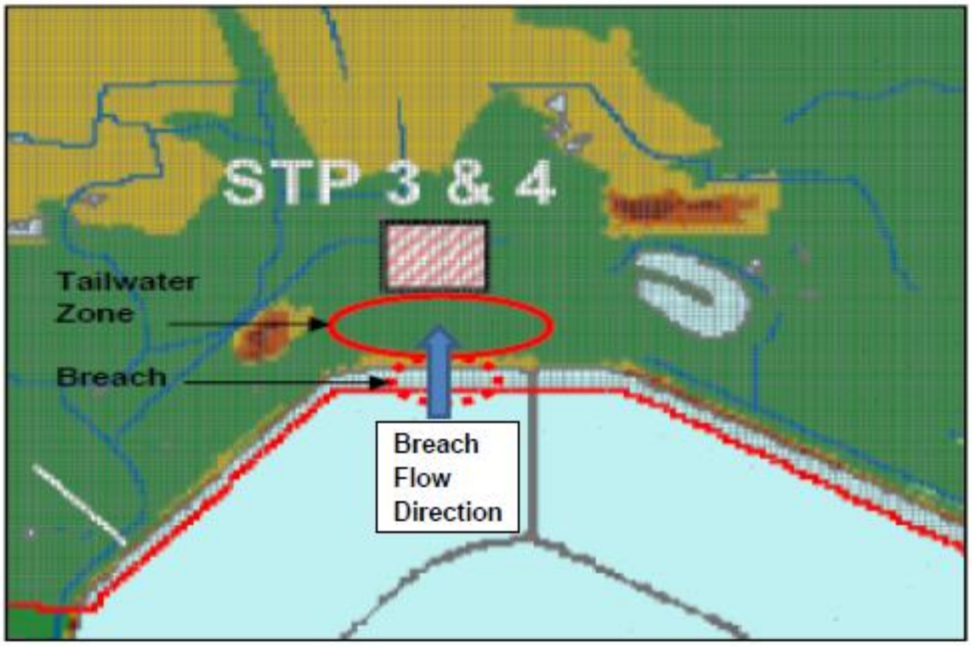
The actual breach tailwater zone is a wide and flat open area (over 0.8 miles as shown in Figure 1 (top)). However, the tailwater cross sections specified in the licensee's and staff's BREACH models were small enough (bottom width of 600 ft) to constrict a full breach growth. This is a rudimentary modeling error. All three external peer reviewers failed to recognize this issue and/or misinterpreted the BREACH modeling and result presented in the re-analysis report.

My Re-analysis

I performed a comprehensive independent modeling study (so-called re-analysis) which was summarized in the non-concurrence document filed in 2011. Three germane technical issues that were discussed in the non-concurrence but are not addressed in this document are (i) selecting proper breach regression equations, (ii) choosing a realistic breach n-value, and (iii) confirming the estimation with historical breach events which are similar to the postulated MCR breach condition. The following is a brief summary of the re-analysis:

- If the two issues discussed here, foundation scouring and tailwater section, were considered correctly, the licensee's design flood level would be 2.4 ft higher than their estimate even with the licensee's n-value of 0.05.
- My re-analysis indicates that a reasonable site design basis flood level should be approximately 45 ft msl or 5 ft higher than the licensee's estimate if all five issues discussed in the non-concurrence are considered correctly.
- Alternatively, applying a very conservative breach width scenario could result in a design basis flood level of 47 ft msl or 7 ft higher than the licensee's estimate.

Figure 1. Description of the Main Cooling Reservoir (MCR) Embankment Dike Breach, where top is a site map with the location of a potential piping breach, and bottom is a schematic diagram of dike breach with a fictitious tailwater cross section specified in the numerical BREACH model by the licensee and staff compared to a realistic tailwater cross section.



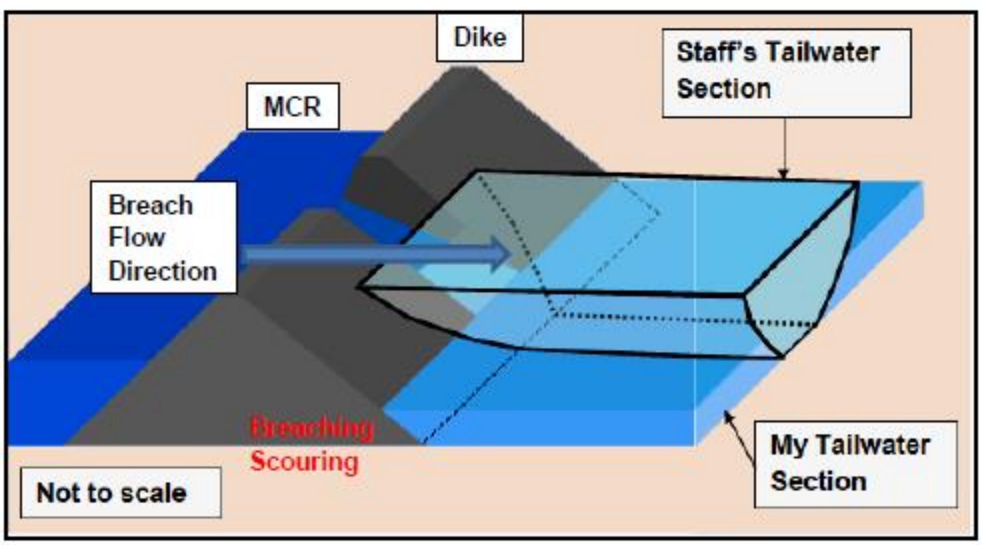
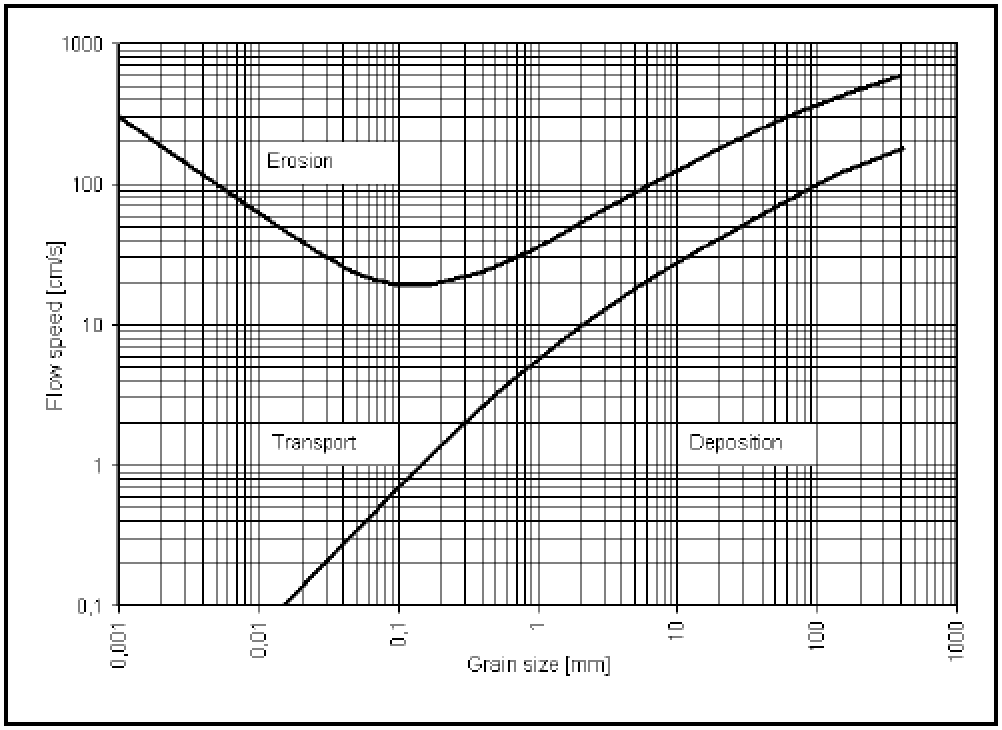
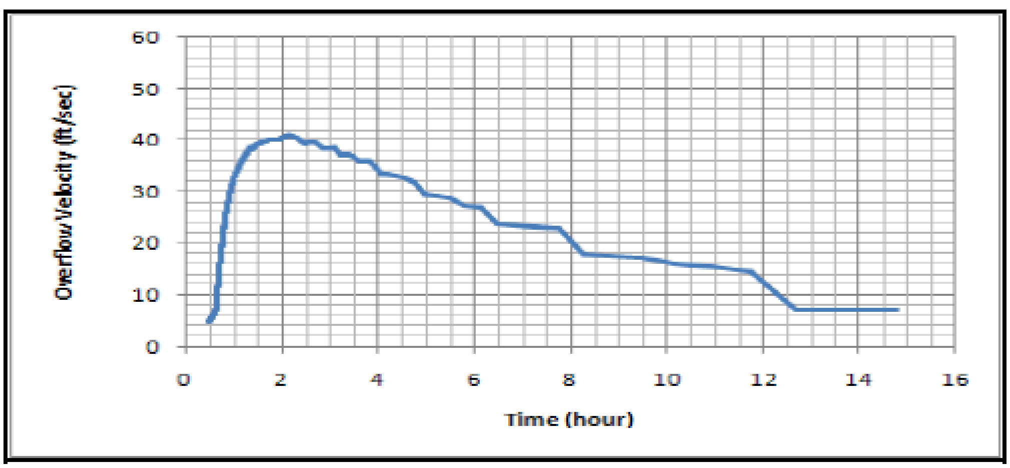


Figure 2. Comparison of the critical erosion velocity and estimated outflow velocities at the postulated MCR breach, where top is the Hjulstrom Curve displaying critical breach flow velocity for erodible embankment soils by grain size (BREACH used grain size of 0.001 mm for MCR dike clay soils), and bottom is the estimated outflow velocity hydrograph generated using the BREACH model with a postulated piping failure scenario in the re-analysis. It should be noted that the flow velocity on the top is centimeters per second while that of the bottom is feet per second.



Note: This figure was downloaded from "https://en.wikipedia.org/wiki/Hjulstr%C3%B6m_curve" on October 26, 2015.



UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
NUCLEAR INNOVATION NORTH AMERICA LLC	)	Docket Nos. 52-012-COL and 52-013-COL
	)	
	)	
(South Texas Project, Units 3 and 4)	)	
	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **OFFICE OF THE SECRETARY NOTICE TO THE PARTIES** have been served upon the following persons by the Electronic Information Exchange.

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South Texas Project, Units 3 and 4
Docket Nos. 52-012-COL and 52-013-COL
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[Original signed by Brian Newell]
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Dated at Rockville, Maryland
this 12th day of November, 2015