UNITED STATES
NUCLEAR REGULATORY COMMISSION

REGION I
475 Allendale Road
King of Prussia, PA 19406

Draft 3 B Mills
Resolved

MEMORANDUM TO: Robert A. Nelson, Deputy Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

FROM: James Clifford, Deputy Director
Division of Reactor Projects

SUBJECT: REQUEST FOR TECHNICAL ASSISTANCE
SEABROOK STATION ALKALI-SILICA REACTION

Region I requests technical assistance from the Office of Nuclear Reactor Regulation (NRR) to evaluate the consequence of alkali-silica reaction (ASR) degradation of one safety related concrete structures at Seabrook Station, and to evaluate the impact of the degradation on the current licensing and design basis by providing guidance on what should be included in the final operability determination. The evaluation is for the Seabrook Control Building ("B" Electrical Tunnel and Penetration Room) in light of a recently discovered degradation mechanism. Additional TIAs may be necessary for other buildings also exhibiting the ASR problem.

Background

NextEra (the licensee) analyzed concrete core samples from the interior surface of exterior walls of the Control Building as part of their assessment to support renewal of their license. In August 2010, tests undertaken as a part of the core sample analysis reported a change in material properties. The analysis reported the presence of an (ASR) in core samples taken from chronically wet walls below grade, with apparent reductions reported in the concrete compressive strength and modulus of elasticity. NextEra evaluated these parametric reductions to determine the impact on the design basis of the Control Building. By their process, the licensee performed an initial and prompt operability determination and concluded, preliminarily, that the Control Building was within the limits of the design basis although with reduced margins.

NextEra continued to evaluate the extent of this condition and, found additional evidence of ASR in other safety related structures. The other five buildings for which concrete core samples were taken were: Equipment Vault (housing ECCS equipment including that for Residual Heat Removal (RHR)], RCA (Radiological Controls Area) Walkway, Emergency Feedwater Building, Emergency Diesel Generator (EDG) Building, and ..... As of June 30, 2011 there are two open prompt operability determinations, one for the Control Buidling and one for the other five buildings collectively.

NextEra's planned actions are two-fold: 1) to follow their operability determination process; and, 2) to follow the guidance in NEI 95-10, "Industry Guideline for Implementing the Requirements of 10 CFR Part 54 – The License Renewal Rule," to develop an aging management program to

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support the license renewal application. Their proposal is described in a letter dated April 14, 2011, under the response to NRC request for additional information B.2.1.31-1 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML11108A131) has periodic reviews for operability as information is developed to support the aging management review. The proposal included another analysis (termed "final" by NextEra) of the impact of ASR on the current licensing and design basis, including the extent of the condition, to be completed by June 2011. On June 29, 2011, the NRR Division of License Renewal issued another "Request for Additional Information" (ADAMS Accession No. ML11178A338) related to key aspects of NextEra's comprehensive plan for assessing the ASR problem for the Structures Monitoring Program including that for the Fuel Handling Building and Containment ("Followup RAI B2.1.31-1, B2.1.31-4, and B2.1.28-3).

The licensee found additional evidence of ASR in the other buildings that were a part of the extent of conditions review; and they evaluated that information in a separate initial and prompt operability determination using the same evaluation techniques as for the Control Building. Based on NRC internal discussions, it appears that the calculation methods and correlations used may not be valid in light of the ASR problem.

With respect to Part 50 requirements, Region I reviewed the NextEra current Structures Monitoring Program and found a violation of the maintenance rule for the control building. The finding is described in detail in NRC Inspection Report 05000443/2011002 (ADAMS Accession No. ML111330689). More details related to the newly discovered ASR issue are also documented in NRC Inspection Report 05000443/2011007 (ADAMS Accession No. ML111360432), which was issued as part of a license renewal inspection. The cover letter for the latter report notes that the aging management review for the ASR issue is not complete and that there is a need for a continuing review in the Part 50 and 54 areas. The staffs of Region I and NRR (Division of Engineering and License Renewal) have been working closely together to ensure the agency reviews this matter in unison and speaks with one voice.

The below listed documents were made available for review on the licensee's "Certrex" internal website. These documents reflect current NextEra view of operability for the Control Building and the associate tunnel and penetration room. The "Certec" system was set up in order address industry concerns related to internal documents being made public through NRC or federal government processes. Please inform Region I and NextEra if the document is to printed for review purposes prior to doing so.

1. (No. 2 on Certrec Document Library Tab List) C-S-1-10159 CALC_000, Rev. 0, 'B' Electrical Tunnel Transverse Shear Evaluation Supplement to Calcuaiton CD-20
2. (No. 4 on Certrec Document Library Tab List) C-S-1-10150 CALC_000, Rev. 0, Effects of Reduce Modulus of Elasticity – 'B' Electrical Tunnel Exterior Walls
3. (No. 5 on Certrec Document Library Tab List) CD-20-CALC, UE Control and Deisel Generator Building Desgin of Material and Walls below grade for Electrical Tunnel and the Control Building (Original Design Calucation)
4. (No. 6 on Certrec Document Library Tab List) Action Request (AR) 581434 Prompt Operability Determination Reduced Concrete Properties Below Grade in 'B' Electrical Tunnel Exterior Walls.

Also before the startup of Seabrook in May 2011, on

April 27, 2011, NRR Division of Engineering provided support by reviewing the following documents - (No. 6 on Certrec Document Library Tab List) Design Change Package Description No. EC-272057, Concrete Modulus of Elasticity for the Control Building Electrical Tunnel and the Containment Enclosure Building which refers to AR No. 581434 (noted above) and AR No. 1644074 which accepts the reduction in modulus of elasticity in light of concrete core testing using a 10 CFR 50.59 screening process. While the screening process was questioned by NRC staff, NRR DE provided a list of questions as noted in the attachment (with one later withdrawal of the question No. 7.)

Licensee Position:

To date, within the limitations of their testing, NextEra has determined that none of the seismic category I structures tested to date have been found to be outside their design basis. The Seabrook design and licensing basis to which the licensee has made these determinations is documented in UFSAR Section 3.8. They are willing to address the attached questions from DE but more likely in the final operability determination currently scheduled for September 30, 2011. In light of the newly discovered ASR issue, it remains unclear to Region I technical reviewers what key aspects must be addressed in the operability determination in order for Region I to independently determine operability of the control building and other structures affected by the ASR problem.

The licensee has posted on the Certrex internal website their operability determination process for reference (EN-AA-203-1001_005, No. 1 on Certrec List)

Requested Actions

Region I requests that NRR reviewed the posted documents on the Certrec internal website supporting the control building ('B' Electrical Tunnel and Penetration room) operability determination for adequacy with particular focus on the below listed key technical questions.

More specifically, NRR's determination should be able for the staff to provide reasonable assurance of continued operability given the concrete degradation identified due to ASR for the control building. If NRR finds that any of the reviewed documents for the control building do not provide reasonable assurance of continued operability of that building, then Region I requests that NRR identify the regulatory or other basis of each concern. Specifically, Region I requests that NRR identify any concerns with the assumptions, methodologies, or calculations, etc., related to items reviewed.

[each item should start out with a well crafted technical question that needs to be addressed in the control building operability determination]

Suresh and Michael this is where you come in from the George Thomas and Abdul Schiek document.

1. Because the original design basis assumes no ASR is present during the design life of the structure, it is not clear how ASR affects the original design assumptions or calculational methods, such as the relationship between compressive strength and modulus of elasticity

to shear capacity and shear force used in the seismic analysis. For example, the assumed relationship between compressive strength and tensile strength may not be valid with ASR present.

2. No tensile strength testing is being performed on the concrete core samples. However, the Region I staff believe that tensile strength is not relevant in a constrained structure after the ASR pressure load is transferred to the rebar. Using ASTM XXXX, the reported tensile values can vary from real values by up to ±40% and, as one researcher said, "...can hardly be assumed to be a material property[1]." Prior to transfer, the pressure contribution appears to be minimal (on the order of less than 5% of the rebar yield based on preliminary research of literature).

1."Review of the splitting-test standards from a fracture mechanics point of view", C. Rocco, G. V. Guinea, J. Planas, and M. Elices

Facultad de Ingeniería, Universidad Nacional de la Plata, La Plata, Argentina, Departamento de Ciencia de Materiales, Universidad Politécnica de Madrid, Madrid, Spain, 5 September 2000

3. A core sample with ASR does not represent the forces contained in the structure because for this test, in particular, rebound is not considered and frictional influences in the test itself are not accommodated. The frictional losses are exacerbated by the standard laboratory practice of placing plywood on opposing faces of the tensile specimen to stop it from rolling off the test stand, thus restraining axial expansion of the sample.

4. Adequacy of concrete core sampling (locations, numbers, frequency of sampling in the future, etc).

5. Completeness of the laboratory testing of core sampling including appropriate parameters obtained along with laboratory test conditions.

6. Need for and completeness of any *in situ* testing of control building conditions including appropriate parameters obtained along with test conditions for now and in the future. As an example, where and how much rebar should be exposed in order to assess the effect on rebar from the ASR issue.

7. Assessment of the effect of the alkali-silica reaction degradation on the current and future ability of the control building to respond to design basis loads, including seismic events.

8. Adequacy of the analysis of the foundations alone vs. the response of a whole structure when the foundation is degraded.

9. Adequacy of the structures monitoring program given the ASR issue – should this be a stand along question

10. Confirm that the attached questions are still valid for the control building operability determination.

11. Confirm that the questions related to the DLR RAI ("Request for Additional Information" (ADAMS Accession No. ML11178A338) related to key aspects of NextEra's comprehensive plan for assessing the ASR problem for the Structures Monitoring Program including that for

the Fuel Handling Building and Containment ("Followup RAI B2.1.31-1, B2.1.31-4, and B2.1.28-3) are valid areas to be addressed in the control building operability determination.

Coordination

This request was discussed between Richard Conte and Michael Modes (RI), and Meena Khanna, George Thomas, and Barry Miller (NRR) during a conference call on 6/17/2011. The TIA was accepted with an agreed upon response date within XX days after receipt.

References

http://portal.nrc.gov/edo/ri/EB1/Shared%20Documents/Forms/AllItems.aspx

Docket No. 50-443

CONTACT: Michael Modes, DRS
(610) 337-5198

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SUNSI Review _____ Complete
DOCUMENT NAME: G:\DRS\Engineering Branch 1\-- MModes\TIA Seabrook ASR Draft 2.docx

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OFFICE	RI	DRS	RI	DRS	RI	DRP	RI	DRS	RI	DRP
NAME	MModes		RConte		ABurritt		PWilson		DRoberts	
DATE	06/ /11		06/ /11		06/ /11		06/ /11		06/ /11	

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Attachment

DE/EMCB Comments on AR1644074 Evaluation of Containment Enclosure Building (CEB) (4-27-11)

1. An important effect of reduction in elastic modulus (Ec) of concrete due to ASR is a reduction in stiffness (axial, flexural, shear) of the affected areas relative to the stiffness of the unaffected areas. This would result in redistribution of forces in the global response of the structure under design loads due to changes in the relative stiffness of the affected and unaffected areas from that considered in the original global structural analyses of the CEB using the SAG computer code. Further, since the ASR degradation is in the lower areas of the CEB, the reduction in elastic modulus could affect the boundary conditions assumed in the original analysis at the junction of the basemat and the CEB wall. Note that FSAR Section 3.8.4.4.a states, in part, that *"Lateral forces are transferred to the foundation mats primarily by the action of shear walls; some load is also transferred by means of flexural action of the wall, all of which are rigidly attached at the mat."* Also refer to pages 11 and 12 of Calculation C-S-1-10150. The AR1644074 Evaluation does not address the effect of the reduced modulus on the global response of the structure. It assumes that the forces and moments in the different elements of the structure under design loads remains the same and only evaluates the local sections (concrete stresses, strains and flexural capacity) for the reduced modulus, which are based on forces and moments from the original structural analysis.

2. The AR1644074 Evaluation does not evaluate the effect of the reduced modulus on the shear capacity of the affected area.

3. The AR1644074 Evaluation does not address the effect of the reduced modulus on the potential changes in the natural frequencies of the CEB structure, which could have effect the response of the structure to seismic load.

4. The AR1644074 Evaluation of the local section does not evaluate the effect of reduced modulus on stress and strain in the rebar. The strain in the rebar could go beyond the yield strain. From page 47 of Calc CE-4 referenced in the evaluation for element 255, the stress in the hoop reinforcement is 61.493 ksi, which is already beyond yield.

5. The AR1644074 Evaluation of the local section is based on element 255, which is 27" thick and appears to be outside the area affected by ASR. The areas affected by ASR appear to be at the lower elevations of the CEB which are 36" thick. A critical element in the affected area needs to be evaluated. Further, note that the forces and moments in element 255 could increase based on Comment 1 above, and thereby further affect concrete and rebar stresses and strains in element 255.

6. The AR1644074 Evaluation does not explicitly evaluate the effect of the reduced modulus on the flexural capacity of affected local sections, but makes reference to Calc

C-S-1-10150 performed for the electrical tunnel. The effect on flexural capacity of the affected Section of the CEB should be explicitly evaluated since the effect of the reduced modulus on moment capacity of a section is a function of the amount of reinforcement in the section, the section dimensions and material properties. The CEB wall reinforcement, dimensions and material properties appear significantly different from that of the electrical tunnel.

~~7. On page 2 of the AR1644074 Evaluation, it is stated that "The reduction in Ec causes the neutral axis of the balanced concrete and reinforcing steel section to shift toward the tension reinforcing steel." It appears that the reduction in Ec would tend to cause the neutral axis to shift toward the extreme compression fiber that the tension reinforcing steel per T~~

Per George Thomas telecon of June 9, 2010 with R. Conte.

8. To have any level of statistical validity, the number of cores used in an evaluation should be at least 3. The AR1644074 Evaluation uses results based on only 2 core tests of the ASR affected area.

9. What are the strain levels at the reported values of concrete compressive strength and elastic modulus from core tests reported in Table 1 of AR1644074? Does petrographic examination of the cores indicate ASR through the thickness of the wall.

10. The AR1644074 evaluation should include a problem statement description of the condition being evaluated and its preliminary extent (at least based on visual inspection) for the structure in question so that an outside reviewer can understand what is being evaluated.