FOIA/PA NO: _____2013-0332_____

GROUP B
RECORDS BEING RELEASED IN THEIR ENTIRETY

In situ Monitoring of ASR-affected Concrete

A study on crack indexing and damage rating index to assess the severity of ASR and to monitor ASR progression

Written By:
Angela Buford

B1

Key Messages:

1. Surface cracking may not be indicative of the conditions of the concrete through the section, and crack indexing measurements may not consistently indicate the level of ASR severity from one structure to another. For each group of similar (i.e., reinforcement detail, size, environmental conditions) structures, additional examinations are necessary to correlate crack measurements to severity of ASR degradation.

2. Crack mapping results should be correlated to actual strains (and therefore stresses) in the concrete and rebar in order to accurately represent the effect of ASR-induced stresses in engineering evaluations for structural behavior.

3. Damage Rating Index (DRI) is a more accurate measure of ASR severity than crack indexing, and alleviates many of the pitfalls of the crack indexing method. DRI should be considered as a method to assess damage related to ASR.

Alkali-Silica Reaction (ASR)

ASR is a chemical reaction that occurs in concrete between alkali hydroxides dissolved in the cement pore solution and reactive silica phases in the aggregates. The product of the reaction is an expansive gel around the aggregate particles, which imbibes water from the pore fluid, and, having much larger volume than the reacting components, triggers a progressive damage of the material (Winnicki and Pietruszczak 2008). The pressures imparted by the gel onto the concrete can exceed the tensile strength of the aggregates and the cement paste and cause microcracking and macrocracking in the aggregate and surrounding paste. With the presence of moisture, the gel expands and can cause destructive cracking and deleterious expansion of the concrete. The extent of the concrete deterioration depends on aggregate reactivity, high levels of alkalinity, availability of moisture, temperature, and structural restraint (Williams, Choudhuri, and Perez 2009). Concrete expansion and cracking can lead to serious operational and serviceability problems in concrete structures (Rivard et al. 2002).

Surface Cracking and Expansion

The Federal Highway Administration (FHWA) Report on the Diagnosis, Prognosis, and Mitigation of Alkali-Silica Reaction in Transportation Structures states that "in concrete members undergoing internal expansion due to ASR and subject to wetting and drying cycles (cyclic exposure to sun, rain, wind, etc.), the concrete often shows surface cracking because of induced tension cracking in the 'less expansive' surface layer (because of variable humidity conditions and leaching of alkalis) under the expansive thrust of the inner concrete core (with more constant humidity and pH conditions)." Cracks first form as three or four-pronged star patterns resulting from expansion of the gel reacting with the aggregate. If the concrete is not subject to directional stress, the crack pattern developed forms irregular polygons, commonly referred to as map cracking (Swamy 1992). This cracking is usually enough to relieve the

pressure and accommodate the resulting volume increase (Figg 1987; reported by Farny et. Al. 2007).

Map cracking is one of the most commonly reported visual signs associated with ASR. The pattern and severity of cracking vary depending on the type and quantity of reactive aggregate used, the alkali content of the concrete, exposure conditions, distribution of stresses, and degree of confinement in the concrete (Smaoui et al. 2004). ASR can also be characterized by longitudinal cracking, surface discoloration, aggregate pop-out, and surface deposits (gel or efflorescence) (Williams, Choudhuri, and Perez 2009). Although pattern cracking is a characteristic visual indication that ASR may be present in the concrete, ASR can exist in concrete without indications of pattern cracking. Newman (2003) noted that "while superficial cracking patterns can often be reminiscent of ASR, it is important to be aware that reliable diagnosis can never be adequately based on the appearance of surface cracking alone." This consideration is also emphasized by Barnes (2001), whose research cites examples where cracking was thought to be and diagnosed as ASR, and also examples in which ASR gel and associated cracked aggregate particles were found in concrete that was uncracked. In addition, in ASR-affected structures with reinforcement close to the surface or in heavily reinforced structures, surface cracking may be suppressed while internal damage exists throughout the section. The presence and extent of surface cracking is not a conclusive indication that ASR is present or measure of concrete degradation due to ASR; and conversely, the absence of surface cracking does not conclusively indicate the absence of ASR.

Crack Mapping/Indexing

In order to determine the effect of ASR on the performance of a concrete structure, it is important that there be an understanding of current concrete condition (ASR damage reached to-date) and the rate of expansion. Crack indexing is a method that is proposed to measure crack widths and expansion of cracks over time. For this visual examination individual crack widths are measured over a defined grid and the total amount of cracking is quantified. The examination is repeated over regular intervals and the results are compared over time, with a goal of establishing a rate of ASR progression. The Institute of Structural Engineers (ISE 1992) proposed a method for crack mapping that consists of measuring the ASR crack widths along five parallel lines that are each 1 m long. Lines are traced directly onto the concrete structure. The total width of intersecting cracks along each line is summed and divided by the length over which they were measured, to determine the severity of ASR cracking, and then over time to determine the rate of expansion. Another method, suggested by Laboratoire Central des Ponts et Chaussees (LCPC 1997), consists of measuring the widths of all cracks intersecting two perpendicular 1m lines originating from the same point and their two diagonals 1.4 m long. The total crack index is determined as a value in millimeters per meter and compared to criteria that correspond to action levels.

Summary of General Discussion on Crack Mapping

It is stated throughout ASR research that crack mapping is somewhat limited in its applicability to understanding ASR degradation in concrete. Saint-Pierre et al. (2007) note that compared to other non-destructive methods developed for assessing the damage induced by ASR, the semi-quantitative surface methods like crack mapping appear to be less effective. It is generally agreed that while results of crack indexing can potentially give some indication of how ASR is progressing over time, establishing an absolute trend that directly correlates expansion levels to ASR progression may not be a reliable practice. Most ASR research also indicates that using crack measurement alone to characterize the current state of ASR degradation would not be advised, since the practice relies on the assumption that the surface cracking on the face of a structure is wholly congruent to ASR severity. In the 2010 Addendum to its report titled "Structural Effects of Alkali-Silica Reaction - Technical guidance on the Appraisal of Existing Structures," ISE stated that the crack summation procedures for estimating expansion to date work well in directions where there is little restraint from structural stress, reinforcement, or prestress. This suggests that in structures with higher restraint, this would not be the case. In addition, crack mapping is limited in that it can only give data on two-way crack measurements and does not capture cracking in the out-of-plane direction. It is suggested that further activities be carried out for assessing current condition of the concrete and current expansion rate, as well as correlating the expansion to structural integrity.

In addition, crack indexing evaluation criteria should not be universally applied to all structures because surface cracking may not give a reliable indication of the ASR degradation to the structure. Due to variability in size, location, environment, reinforcement detailing, and relative severity of ASR damage, it may be necessary to obtain an understanding of the ASR effects for each individual structure or group of structures with similar physical properties and environments. Indeed, Newman (2003) stated "it is important to relate cracking patterns variously to structural geometry and/or design, apparent concreting sequence, localized detailing (especially where cracking may be coincident with water leakage) and both environmental and in-service conditions." Deschenes et al. (2009) also state that research into the method highlighted that a number of factors (size and shape of member, restraint present, depth of cover, etc.) leading to poor correlation between crack indexing and measured expansions.

Surface Cracking vs. Internal ASR Damage

The correlation between surface cracking and ASR deterioration may be closer to unity for specimens used in the laboratory that are only allowed to deteriorate due to ASR conditions. However, for concrete in the field, the surface indications sometimes poorly correlate to the extent of ASR degradation within the concrete. Since conditions are so variable from one region to another, and even from one place to another in the same structure, poor correlations are often observed between the severity of surface cracking and the presence of the internal signs of ASR (i.e., reaction products, micro-cracking, and expansion) (Nishibayashi et al. 1989 and Stark 1990 reported by Smaoui et al. 2002). Development of cracking on the surface

depends strongly on the amount of reinforcement close to the surface (Smaoui et al. 2002) and also depends on external environmental conditions such as wetting-drying, freezing-thawing, and exposure to saline solutions (Smaoui et al. 2002). Two examples of situations in which external conditions can affect the surface cover concrete such that the surface features are not indicative of the actual ASR degradation of the structure are presented here for consideration. In one case, presence and extent of surface cracking can depend on the pH of the surface which can be affected by leaching and carbonation. As such, wetting-drying cycles can affect the features of ASR, as conditions at the surface layer could be less favorable to the development of ASR, due to the [lower] humidity during the drying periods and the leaching of alkalis during the wetting periods (Poitevin 1983 and Swamy 1995, reported by Smaoui et al. 2004). In other words, if the outer surface layer of concrete is exposed to conditions that would cause the ASR severity or development to be lower, but conditions inside the concrete remain conducive to ASR development (i.e., high relative humidity); surface conditions would not be representative of the ASR within the concrete section. Crack indexing efforts would incorrectly characterize the level of ASR degradation as minor, when within the section the ASR degradation might be more severe.

Another example in which environmental conditions have caused surface conditions to be different than conditions within the concrete is the subject of a study done by Berube et al (2002). In this study, an attempt was made to correlate ASR expansion with type of exposure to moisture. Results showed that in specimens exposed to wetting-drying cycles saw more surface cracking but less actual expansion than specimens that were always exposed to humidity. In this case, the larger amount of surface cracking evident in the specimens exposed to wetting-drying cycles did not show to correlate well to the actual expansion due to ASR, with the ASR expansion being less severe than the cracking would indicate. Conversely, the specimens that showed less surface cracking saw a greater expansion due to ASR, which shows that visual examination of surface cracking alone may not be adequate.

Smaoui et al. (2004) state that although the intensity of surface cracking on ASR-affected concrete in service can help to assess the severity of ASR, quantitative measurement of this intensity [i.e., crack mapping] [could] lead to values that generally underestimate the true expansion attained, except maybe when the surface concrete layer does not suffer any ASR expansion at all. If the concrete surface layer undergoes ASR expansion that is less than that of the inner concrete, according to Smaoui et al. (2004), "the measurement of surface cracking will tend to give expansion values lower than the overall expansion of the concrete element under study." This research indicates that the degree of correlation between surface cracking and actual ASR expansion or degradation tends to vary with the level of exposure, which means that crack indexing over a number of structures with varying environmental conditions may not conclusively measure the extent or severity of ASR degradation.

ASR-induced Stresses

The ISE (2010) noted that for some structures exposed to ASR, internal damage occurs through the depth [of the section] but visible cracking is suppressed by heavy reinforcement. In

reinforced concrete structures, expansion of ASR cracks generates tensile stresses in the reinforcing steel while also causing compressive stresses in the concrete surrounding the rebar (this phenomenon is often likened to prestress in the concrete and noted to temporarily improve structural behavior). According to Smaoui et al., 2004, the most useful information in the structural evaluation of an ASR-affected concrete member is the state of the stresses in the concrete, but more importantly in the steel reinforcement. The ASR-induced stresses increase the structural demand on the steel and concrete, but this new design load has likely not been accounted for in the original design or in further structural evaluations. According to Multon et al. (2005), "assessment models have to take into consideration the property of stresses to modify ASR-induced expansions and their effect on the mechanical response of ASR-damaged structures..." The expansion reached to date, the current rate of expansion, and the potential for future expansion of the concrete are particularly critical pieces of information to determine whether or not the reinforcing steel has reached or will at some point reach its plastic limit, thus creating risk of structural failure (FHWA 2010).

Crack mapping alone to determine ASR effects on the structure does not allow for the consideration of rebar stresses. Visual examination and measurement of crack growth should be correlated to strain measurements taken of ASR-affected concrete and the reinforcing steel. In similar structures, then, the visual indications of expansion due to ASR can relate to stresses in the concrete and reinforcing steel in order to apply ASR-induced stress as an additional load in structural evaluations. Smaoui et al., 2004 propose that if it is not possible to do a destructive examination (i.e., exposing the rebar or taking deep cores) of the structure in question, "an indirect method is based on the expansion accumulated to date...Assuming that this expansion corresponds to that of the reinforcement steel, the stresses within the reinforcement and the concrete could thus be determined from the modulus of elasticity of the steel and the corresponding sections of the concrete elements under investigation." For determining added stresses in in situ structures, once correlation has been made with respect to size and rebar configuration between the in situ structure and a test specimen, it would be appropriate to use crack mapping as a measure of ASR degradation when introducing the additional ASR-induced stresses on concrete and reinforcing steel in structural evaluations.

Discussion on Applicability of Crack Indexing

This report is not intended to present the position that crack indexing and resulting data should not be part of a structural monitoring program to assess the ongoing effects of ASR in concrete. In fact, crack indexing is recommended by the Federal Highway Administration (FHWA 2010) "to obtain a quantitative rating of the 'surface' deterioration of the structure as a whole" (it should be noted that in the FHWA document, the word "surface" is emphasized with quotation marks, which implies recognition that crack indexing measurements alone provide information limited only to what is occurring at the concrete surface). This report's position is that crack mapping can only be useful once there is an understanding of how the conditions inside the concrete, (i.e., relative humidity, presence and severity of cracking, and added stresses in the concrete, reinforcing detail) correlate to the cracking observed at the surface. The FHWA (2010) document agrees, indicating that to obtain an understanding of the current state of ASR

degradation and in order to correlate the surface cracking to the actual effects of ASR-induced expansion on the structure, other investigations of the in-situ structure are necessary. In addition to crack indexing, some FHWA recommendations for transportation structures that can be appropriately applied to nuclear structures include taking stress [strain] measurements in reinforcing steel, obtaining temperature and humidity readings, and performing non-destructive testing such as pulse velocity measurements (the recommendation to use pulse velocity measurements is in agreement with the experimental findings of Saint-Pierre et al. 2007). The Institution of Structural Engineers (ISE 2010) suggests that expansion to date and severity of ASR should be evaluated using examination and testing of cores for changes in modulus of elasticity and development of hysteresis (stiffness deterioration). It is also proposed that strain sensors be used as a method of monitoring ASR progression (Harries 2012) in order to monitor and quantify out-of-plane expansion.

In addition to provisions for monitoring (or predicting) progression of ASR, it is recommended that each structure or group of similar structures undergo petrographic analysis to determine the current state of ASR damage, in order to provide an accurate baseline from which to understand the current severity level and monitor ASR progression.

Discussion on Applicability of Damage Rating Index

The damage rating index (DRI) was developed by Grattan-Bellew and Danay in 1992 (Reported by Smaoui et al. 2004) as a method to determine the extent of internal damage in concrete affected by ASR (Rivard et al. 2002). The DRI is a method for quantifying both qualitative and quantitative observations and determining severity of ASR using petrographic analysis of polished sections of concrete. It is based on the recognition of a series of petrographic features that are commonly associated with ASR (Rivard et al. 2002). The DRI accounts for defects observed in the concrete, such as the presence and distribution of reaction products, existence of internal microcracking, and location of microcracking (within the aggregate vs. through the cement paste) by assigning a weighting factor to each and quantifying overall damage. When the factors are normalized to an area of 100 cm^2, the resulting number is the DRI. Rivard et. Al. (2000) noted that the abundance of individual defects and the overall DRI values increased with regularity with increased ASR expansion. It should be noted that the specimens used by Rivard et. Al. were comprised of reactive aggregates with different reaction mechanisms, but ASR expansion indeed correlated with DRI measures of ASR severity.

Smaoui et al. (2004) performed damage rating indexing on specimens from five concrete mixes using different reactive aggregates to determine if there was a reliable and accurate correlation between ASR damage determined by DRI and ASR expansion measurements. They noted that there exists a potential error in estimating expansion of ASR concrete in the field and establishing a DRI-expansion relationship with laboratory testing. In some of the lab specimens, relatively similar DRI values were obtained for very different expansion levels for cylinders which had been cast with the same concrete mix (and progressed ASR over time). The tests indicated that expansion levels (of in situ structures compared to laboratory specimens) may not be the best indication of ASR degradation. For example, the presence of air bubbles in the proximity of

reactive aggregates [in field concrete] usually has the effect of reducing the expansion due to ASR (Landry 1994, Reported by Smaoui et al. 2004). In other words, air bubbles that exist in the in situ concrete structure could result in a smaller expansion of the structure as concluded under crack mapping activities while more severe ASR damage could be present in the structure because ASR features have "room" to grow inside the existing structure before extensive cracking is notable on the concrete surface. Smaoui et al. (2004) concluded that "for evaluating the expansion attained to date by ASR-affected concrete, it may be necessary to reconsider the relevant defects and their respective weighting factors and take into account a certain number of factors such as the presence or absence of entrained air and preexisting cracks and alteration rims" to assess the severity of ASR in structures. It is notable that the research done by Rivard et al. (2000) showed that DRI correlated well with actual ASR expansion, while subsequent work done by Smaoui et al. (2004) proposed that in some cases lack of gross expansion did not correlate to low ASR degradation, and that air bubbles prevented macro-level expansion even though ASR effects were severe. Crack indexing would not have identified this severe ASR progression since that method only measures expansion of surface cracks,

Rivard et al. noted a possible limitation of the DRI method: that weighting factors assigned to each defect may not universally apply to all types of reactive aggregates (reported by Smaoui et al. 2004) and that weighting factor adjustments may be needed depending on the type of reactive aggregate being examined. In other words, DRI results (and their correlation to concrete expansion) should not be applied universally between concretes with different aggregates (with different types of siliceous materials), However, the FHWA (2010) notes that the DRI method can be useful for quantitative assessment of ASR damage for concretes with the same constituents (i.e., same type of reactive aggregate and cement mix design), and can provide useful relative information when cores are taken and a damage rating developed for each structure by the same experienced technician.

Conclusion/Recommendations

In order for the effects of ASR on concrete to be understood, the parameters that need to be understood are (1) the amount of cracking inside the concrete, (2) ASR-induced expansion-to-date and rate of expansion, and (3) effects of ASR on concrete and rebar stresses. To understand the affects of ASR on structural behavior, the effects of ASR damage inside the rebar cage should be applied to engineering analyses or laboratory testing of an equivalent structure for each group of similar structures.

Visual examination of the concrete surface, without any other information about the concrete beneath the surface, is not recommended for either determining the current level of ASR degradation or projecting the future effects of ASR in concrete. Crack indexing would be an adequate and reasonable method of monitoring ASR progression once surface cracking can be correlated to actual ASR degradation, including cracking, expansion, and corresponding stresses (strains) in the concrete and rebar. Laboratory and in-situ testing must be performed to correlate surface cracking with loss of mechanical properties because cracking patterns may

vary for different structural geometry and/or design, apparent concreting sequence, localized detailing (especially where cracking may be coincident with water leakage) and both environmental and in-service conditions (Newman et al. 2003).

At a minimum, for each set of structures with the same environmental conditions (e.g. chronically wetted, exposed to freeze-thaw action, constant wetting/drying) and section properties (e.g. wall thickness, rebar layout), an initial petrographic analysis should be done to establish the current state of ASR degradation. The severity of ASR damage on the inside of the structure should be correlated to the surface cracking found on the face of the concrete. The expansion measured by subsequent periodic crack indexing can then be assessed on a structure by structure basis depending on that correlation. Also, depending on the correlation between the surface and interior indications for each set of structures, it may be appropriate to adjust the individual crack width and CCI acceptance criteria for different groups of structures. An added benefit to doing an initial petrographic analysis is that the cores removed from the structure could be studied for subparallel microcracking that would not be detected from crack mapping efforts, which only show cracks on the surface face. This is the minimum effort that should be undertaken to gain at least a more informed understanding, for each set of similar structures (physical attributes and environmental conditions), of the ASR expansion reached to date and rate of expansion. The ability to correlate in situ conditions with laboratory testing would strengthen the reliability of the crack indexing method.

A recommended "more than minimum" approach to monitoring ASR progression would be the use of embedded strain sensors in the concrete to provide a measure of expansion in the concrete. This would provide the most accurate measure of expansion due to ASR and would provide the benefit of understanding expansion due to cracking in the third direction. The application of strain instrumentation would also be able to quantify strains (stresses) on the rebar and concrete in order to apply the additional demand due to ASR to a structural engineering evaluation. Finally, this method would help to establish a rate of expansion in the concrete, and could provide insights into understanding the ASR degradation mechanism, including relating environmental conditions specific to a structure to the rate of change of ASR progression, in order to characterize the potential and extent of continued degradation over time. The data could also be used in engineering analyses to predict the effects of ASR on structural behavior.

The DRI method has been shown to be an effective method for assessing the damage level of ASR-affected structures. However, due to the limitation of this method in being able to apply weighting factors consistently between various types of aggregates, practical implementation of this method would mean that site-specific criteria for severity ratings and weighting factors for ASR indications may need to be established in accordance with the reactivity of the aggregate used on site. Also, since there is no standard test procedure available and thus the DRI method results could be variable from one petrographer to another, it would be important to ensure quality and consistency in the implementation of the method. If consistency could be ensured through quality of the technician performing the initial examination and subsequent

examinations, the DRI would provide a beneficial and useful understanding of current ASR degradation and degradation over time.

References

(coming soon)

Buford, Angela

From: Buford, Angela
Sent: Tuesday, January 22, 2013 10:51 AM
To: Conte, Richard
Subject: RE: Plans for Next Week in Texas RE: Discussion Points/Outline

Rich, I'm here on site let me know when works best for you to conference RE next week.

From: Conte, Richard
Sent: Tuesday, January 22, 2013 7:15 AM
To: Cook, William; Buford, Angela
Cc: Trapp, James; Floyd, Niklas; Raymond, William; Khanna, Meena; Chaudhary, Suresh
Subject: Plans for Next Week in Texas RE: Discussion Points/Outline

Angie were we to conference today Tuesday Jan. 23 on the inspection plans for next week?

See attached draft. Bill told me Friday when I got back to the US that Melanie wanted some input or discussion on the matter.

I had not as yet received an appointment or email about it, then again I have so many I might have missed it.

Over the weekend I had a filling come out so I need to tend to it before next week when we are in Texas. I need to be off on sick leave this PM but Iwill be here this AM to 1130. Will be here all day Wednesday and Thursday. Not sure about this Friday AM but sure for PM.

From: Cook, William
Sent: Friday, January 18, 2013 8:10 AM
To: Khanna, Meena
Cc: Trapp, James; Floyd, Niklas; Buford, Angela; Conte, Richard; Raymond, William
Subject: Discussion Points/Outline

Meena,
The points that we hope to make with NextEra next week are outlined below. I think this will facilitate our discussion today. I welcome any insights/feedback on how best to discuss these topics with NextEra. Please call when convenient for you.
Thanks,
Bill

Compliance with ACI 318-71

- Team reviewed and discussed Chapter 1 (para 1.4) and Chapter 20 applicability to Seabrook proposed testing
- Paragraph 1.4 does not apply (construction design phase); and 2011 version explicitly refers to Chapter 20 for "evaluation of existing structures." The Code is silent with respect to a time frame of applicability subsequent to initial construction.

- Chapter 20 "Strength Evaluation of Existing Structures," defines structural strength evaluations by either in-situ load test or analysis, or combination of these two methods. The prescribed analytical evaluation method involves actual structural details and material properties from the affected structure.

- Consequently, an evaluation other than prescribed by Code, requires Building Official review and approval (a licensing action). The 2011 version of ACI 318 is more explicit about the details of a load test or analysis and it is clear to the NRC staff that testing of large scale specimens is not covered by ACI 318. Conditions involving deterioration (such as ASR) are specifically addressed in the 2011 version, 20.1.4 and commentary R20.1.4 pertaining to periodic evaluations and the agreement of all concerned parties

- 10CFR50.59 is explicit, a licensee shall obtain a license amendment pursuant to 50.90 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would; (viii) result in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases of the safety analysis

- May seek approval (license amendment) in advance of applying the results of UT-A testing or seek approval (license amendment) upon completion of the testing, thereby proceed at your own risk.

- Question: What supports NextEra belief that the testing approach is a viable path? (NRC review of ACI 326 for shear capacity determination appears to be a viable methodology, but what other limiting states does NextEra plan to evaluate by testing and by what methodology?)

- Next Step: NextEra's response will determine.

Structures Monitoring Program, Revision 2

- Evaluated per Appendix B, Criterion XVI – not acceptable, specifically:
    - Adequate baseline not established (petrographic analysis, material properties, and extent of condition) for future reference
    - No plans for periodic material property sampling
    - Selected monitoring methodology (CCI) does not sufficiently characterize the current state of degradation or progression rate (due to implementation – two dimensional measurements only, cyclic temperature and humidity changes, no differentiation between reaction mechanisms)
    - Ground water chemistry evaluation and analysis program insufficiently established
- NextEra should commit and follow ACI 349.3R guidance (Position Paper)
- Additional SMP considerations/recommendations due to ASR warrant incorporation for appropriate monitoring purposes and research/data collection.

William A. Cook
Senior Reactor Analyst,
USNRC, Region I

(610) 337-5074 (work)
(610)-937-7584 (cell)

Buford, Angela

From: Buford, Angela
Sent: Friday, January 18, 2013 2:40 PM
To: Khanna, Meena
Subject: RE: Telecon with NextEra on LR and ASR Testing

FYI

-----Original Appointment-----
From: Milano, Patrick
Sent: Friday, January 18, 2013 2:17 PM
To: Morey, Dennis; Marshall, Michael; Buford, Angela; Sheikh, Abdul; Erickson, Alice
Cc: Trapp, James
Subject: Telecon with NextEra on LR and ASR Testing
When: Wednesday, January 23, 2013 1:00 PM-2:30 PM (GMT-05:00) Eastern Time (US & Canada).
Where: HQ-OWFN-06B02-12p-VTC

Telecon with NextEra-Seabrook regarding the use of ASR tests to inform structures management program for license renewal and, if so, should the staff be reviewing the test protocol information at this time.

Bridge No.: 800-369-3350

Passcode: 40657#

Buford, Angela

From: Buford, Angela
Sent: Friday, January 18, 2013 10:04 AM
To: Floyd, Niklas
Subject: RE: Floyd Comments on Crack Indexing Position Paper

Yea I'll only be there all day Tuesday and half day Wednesday. Since I'm going to Tx next week, 1.5 days on site was all my BC would support...

Also – one of your good comments on the paper was the possible need for distinction or precision in using the word "concrete" and if the paper should say "reinforced concrete". In structural engineering, when we say "concrete", we always mean reinforced concrete, and if we're referring to unreinforced concrete, that's when we would specify that it's unreinforced...however, your point is well taken because that's not intuitive to someone who's not a structural engineer and it's worth being as clear as possible. so thanks for bringing that to my attention.

See you next week!

Angie

From: Floyd, Niklas
Sent: Friday, January 18, 2013 7:53 AM
To: Buford, Angela
Subject: RE: Floyd Comments on Crack Indexing Position Paper

Yes, I'm driving up early on Tuesday and I'll be there until Friday. I believe Bill said you were planning on being there as well, right?

From: Buford, Angela
Sent: Thursday, January 17, 2013 4:54 PM
To: Floyd, Niklas
Subject: RE: Floyd Comments on Crack Indexing Position Paper

Thanks. Incorporating these.

Will you be on site next week at Seabrook?

From: Floyd, Niklas
Sent: Monday, January 14, 2013 11:43 AM
To: Buford, Angela
Cc: Marshall, Michael
Subject: Floyd Comments on Crack Indexing Position Paper

Angie,

Attached are my comments on the "In-situ monitoring of ASR-affected concrete" position paper. The comments are mainly format related. Please email me or call my office telephone if you have any questions.

Thanks,

Niklas Floyd
USNRC Region I
Reactor Inspector
Division of Reactor Safety
(610) 337-5282

Buford, Angela

From: Buford, Angela
Sent: Thursday, January 17, 2013 4:54 PM
To: Floyd, Niklas
Subject: RE: Floyd Comments on Crack Indexing Position Paper

Thanks. Incorporating these.

Will you be on site next week at Seabrook?

From: Floyd, Niklas
Sent: Monday, January 14, 2013 11:43 AM
To: Buford, Angela
Cc: Marshall, Michael
Subject: Floyd Comments on Crack Indexing Position Paper

Angie,

Attached are my comments on the "In-situ monitoring of ASR-affected concrete" position paper. The comments are mainly format related. Please email me or call my office telephone if you have any questions.

Thanks,

Niklas Floyd
USNRC Region I
Reactor Inspector
Division of Reactor Safety
(610) 337-5282

Buford, Angela

From: Buford, Angela
Sent: Tuesday, January 15, 2013 12:12 PM
To: Fuhrmann, Mark
Subject: RE: are you looking for comments on the paper "In-situ Monitoring of ASR-affected Concrete"?

Thanks - Good idea, will do.

From: Fuhrmann, Mark
Sent: Tuesday, January 15, 2013 11:41 AM
To: Buford, Angela
Subject: RE: are you looking for comments on the paper "In-situ Monitoring of ASR-affected Concrete"?

Ok, thanks....i am reading the paper now.... it is good. There is an ASR Sharepoint site here in RES....could you drop copies of the references in that?

Mark Fuhrmann, Ph.D.
Geochemist
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Mail Stop CSB 2C-07m
11555 Rockville Pike
Rockville, MD 20852-2738

mark.fuhrmann@nrc.gov
Phone: 301-251-7472
Fax: 301-251-7410

From: Buford, Angela
Sent: Tuesday, January 15, 2013 11:07 AM
To: Fuhrmann, Mark
Subject: RE: are you looking for comments on the paper "In-situ Monitoring of ASR-affected Concrete"?

No. If you see one you need, let me know and I'll get it for you. I plan to have that section done this week, and I think Friday was the deadline for the group to provide comments. When I finish it, I'll send to you (and Herman, I'm sure he'd be interested in the references as well)

From: Fuhrmann, Mark
Sent: Tuesday, January 15, 2013 10:44 AM
To: Buford, Angela
Subject: RE: are you looking for comments on the paper "In-situ Monitoring of ASR-affected Concrete"?

Ok, I'll take a look at it...do you have the references put together yet?

Mark Fuhrmann, Ph.D.
Geochemist
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

Mail Stop CSB 2C-07m
11555 Rockville Pike
Rockville, MD 20852-2738

mark.fuhrmann@nrc.gov
Phone: 301-251-7472
Fax: 301-251-7410

From: Buford, Angela
Sent: Tuesday, January 15, 2013 8:49 AM
To: Fuhrmann, Mark
Subject: RE: are you looking for comments on the paper "In-situ Monitoring of ASR-affected Concrete"?

Yes, I am seeking comments on this paper. Right now, I'm not aware that it has been combined with any other papers.

From: Fuhrmann, Mark
Sent: Monday, January 14, 2013 4:56 PM
To: Buford, Angela
Subject: are you looking for comments on the paper "In-situ Monitoring of ASR-affected Concrete"?

Hi Angela:
Are you looking for comments on the paper "In-situ Monitoring of ASR-affected Concrete"? or was this one of the papers that were combined.
The phone conversation last week was a bit confusing in this regard.
Mark

Mark Fuhrmann, Ph.D.
Geochemist
Office of Nuclear Regulatory Research
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11555 Rockville Pike
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mark.fuhrmann@nrc.gov
Phone: 301-251-7472
Fax: 301-251-7410

Buford, Angela

From: Buford, Angela
Sent: Tuesday, January 15, 2013 11:07 AM
To: Fuhrmann, Mark
Subject: RE: are you looking for comments on the paper "In-situ Monitoring of ASR-affected Concrete"?

No. If you see one you need, let me know and I'll get it for you. I plan to have that section done this week, and I think Friday was the deadline for the group to provide comments. When I finish it, I'll send to you (and Herman, I'm sure he'd be interested in the references as well)

From: Fuhrmann, Mark
Sent: Tuesday, January 15, 2013 10:44 AM
To: Buford, Angela
Subject: RE: are you looking for comments on the paper "In-situ Monitoring of ASR-affected Concrete"?

Ok, I'll take a look at it...do you have the references put together yet?

Mark Fuhrmann, Ph.D.
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Phone: 301-251-7472
Fax: 301-251-7410

From: Buford, Angela
Sent: Tuesday, January 15, 2013 8:49 AM
To: Fuhrmann, Mark
Subject: RE: are you looking for comments on the paper "In-situ Monitoring of ASR-affected Concrete"?

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Hi Angela:
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mark.fuhrmann@nrc.gov
Phone: 301-251-7472
Fax: 301-251-7410

Buford, Angela

From: Buford, Angela
Sent: Wednesday, January 09, 2013 3:26 PM
To: Erickson, Alice; Marshall, Michael
Subject: HEADS UP: Structures Monitoring Paper FW: ASR Working Group Meeting

Michael and Alice, I think you were on this distribution. It just probably wasn't clear because the email subject didn't specify the paper was enclosed. See attachment below

---

From: Cook, William
Sent: Tuesday, January 08, 2013 3:50 PM
To: Conte, Richard; Ali, Syed; Buford, Angela; Cartwright, William; Chaudhary, Suresh; Cline, Leonard; Cruz, Holly; Erickson, Alice; Floyd, Niklas; Fuhrmann, Mark; Graves, Herman; Hogan, Rosemary; Hughey, John; Khanna, Meena; Kobetz, Timothy; Lamb, John; Manoly, Kamal; Marshall, Michael; Merzke, Daniel; Milano, Patrick; Morey, Dennis; Murphy, Martin; Ott, William; Philip, Jacob; Raymond, William; Schroeder, Daniel; Sheikh, Abdul; Sircar, Madhumita; Stuchell, Sheldon; Thomas, George; Trapp, James
Subject: RE: ASR Working Group Meeting

One of the brief discussion topics tomorrow is the proposed Structures Monitoring Program position paper. I have attached the January 7, 2013 Draft, if you are interested. I do not plan to go into detail about its content, just introduce the proposed recommendation.

Thanks,
Bill

-----Original Appointment-----
From: Conte, Richard
Sent: Saturday, January 05, 2013 2:22 PM
To: Conte, Richard; Ali, Syed; Buford, Angela; Cartwright, William; Chaudhary, Suresh; Cline, Leonard; Cook, William; Cruz, Holly; Erickson, Alice; Floyd, Niklas; Fuhrmann, Mark; Graves, Herman; Hogan, Rosemary; Hughey, John; Khanna, Meena; Kobetz, Timothy; Lamb, John; Manoly, Kamal; Marshall, Michael; Merzke, Daniel; Milano, Patrick; Morey, Dennis; Murphy, Martin; Ott, William; Philip, Jacob; Raymond, William; Schroeder, Daniel; Sheikh, Abdul; Sircar, Madhumita; Stuchell, Sheldon; Thomas, George; Trapp, James
Subject: ASR Working Group Meeting
When: Wednesday, January 09, 2013 2:00 PM-3:00 PM (GMT-05:00) Eastern Time (US & Canada).
Where: Phone or Office

When: Wednesday, January 09, 2013 2:00 PM-3:00 PM (GMT-05:00) Eastern Time (US & Canada).
Where: Phone or Office

Note: The GMT offset above does not reflect daylight saving time adjustments.

~~*~*~*~*~*~*~*~*~*~*

Agenda and Talking Points are below:

<< File: ASR WGM of 01-09-2013.docx >>

Hope to discuss 3 position papers, Bill Cook with send the third next week – latest Conte has is below

<< File: Assessment of ACI 318-71 as Design Basis - AErickson ASheikh HGraves GThomas MMarshall (11-9-2012).doc >>

<< File: In-situ Monitoring of ASR Paper, 2012-12-19 (Final).doc >>

Buford, Angela

From: Buford, Angela
Sent: Wednesday, January 09, 2013 11:17 AM
To: Cook, William; Trapp, James
Subject: Quick discussion RE: ACI 318 Code Official

Bill, Jim,

Before today's ASR Working group meeting, I'd like to have a quick chat on what we heard from the licensee today with regards to building code official. Do you have 15 minutes to conference and give me a call before 2pm?

I can quickly set up a bridge to tie in Bill Raymond, if he is also available.

Angela R. Buford | Structural Engineer
Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852
t: 301.415.3166
angela.buford@nrc.gov

Buford, Angela

From: Buford, Angela
Sent: Wednesday, January 09, 2013 9:16 AM
To: DLR_RASB Resource
Subject: Accepted: ASR Working Group Meeting

Buford, Angela

From: Buford, Angela
Sent: Tuesday, January 08, 2013 11:38 AM
To: Conte, Richard
Subject: RE: Request Change to Agenda RE: NRC Conference Call - ASR

Rich, have you made your hotel reservations? I'm not finding a rate within gov't per diem nearby.

From: Conte, Richard
Sent: Thursday, January 03, 2013 9:40 AM
To: Vassallo, Theodore
Cc: Brown, Brian; Noble, Rick; Raymond, William; Buford, Angela
Subject: RE: Request Change to Agenda RE: NRC Conference Call - ASR

This sounds great, Angie and I may be getting in the mid afternoon of Monday and Suresh will join up by noon on Tuesday. We can go to an entrance on Monday afternoon and we can start looking at any records we ask for (beforehand) on Tuesday. Maybe tour on Tuesday afternoon when Suresh gets there.

As a I recall you stay at the nearby Hampton Inn.

From: Vassallo, Theodore [mailto:Theodore.Vassallo@nexteraenergy.com]
Sent: Thursday, January 03, 2013 8:49 AM
To: Conte, Richard
Cc: Brown, Brian; Noble, Rick; Raymond, William
Subject: RE: Request Change to Agenda RE: NRC Conference Call - ASR

Rich;

I have confirmed that MPR Associates and the University of Texas at Austin FSEL can accommodate the NRC inspection team the week of 1/28/13, with the NRC arriving at FSEL on 1/29/13. Do you have an exit date in mind? I will arrive in Austin on Monday, 1/28 and returning to Boston on a 6:30 PM flight on Thursday, 1/31/13. Since I booked early the round trip Jet Blue ticket was only $257.00.

Next Tuesday 1/8/13, I will have a list of activities that will be in progress at the FSEL the week of 1/28. I will share this information during the NRC/NextEra call on Wednesday, 1/9/13 so that you can plan your inspection activities. I would also gladly suggest the foreign printed documents that the NRC may want to review to support your activities at FSEL.

I believe that I previously sent you the list of local hotels, restaurants and a map of the area. If you need another copy of these documents just let me know.

Regards,

ted

From: Conte, Richard [mailto:Richard.Conte@nrc.gov]
Sent: Wednesday, January 02, 2013 9:20 AM
To: Willoughby, Paul; Noble, Rick; Vassallo, Theodore; Brown, Brian; OKeefe, Michael; Cliche, Richard; Cook, William; Raymond, William; Chaudhary, Suresh; Buford, Angela; Floyd, Niklas; Trapp, James
Subject: Request Change to Agenda RE: NRC Conference Call - ASR

Would like to change agenda in light of recent developments.

Please check on available for Texas personnel for inspection by Suresh, Angie and myself the week of 1/28 most likely arrive on Tuesday AM 1/29.

New question added to No. 9.

call in number 305-552-3000 passcode 7737745

Agenda:

1. Continue dialog on R&D for Shear and Lap-splice (CAL#8)
2. Continue dialog on R&D for Embedment and Anchor Bolt Testing (CAL#11):

3. Related question for item 2 as to what are the testing specificaitons: Ted and Bill R. were to get together and ID spec for this – ID 66 and 67 on Certrec, ID Foreign Print?
4. In light of latest CAL letter to submit detailed plans by Feb. 28, 2013, how can you start testing in this area before then?

5. Any update to schedule completion for Phase III Walkdown and Baseline Primary Containment for ASR
6. Please ID dates for IAEA review to avoid inspection week conflicts – ASR group will most likely do last full week of the month starting Jan. 28 – we will need to coordinate on NRC teams also.
7. Chaudhary, Buford, and Conte would like to go to U of T for a Quality Assurance review on actions to date and familiarization visit the week of Jan. 28 – bad time? or is the week of Feb. 4 or Feb. 11 better.
8. Finally, when will the RCE revision (CAL # 2) be in.
9. NEW: Any developments on questions raised from last call as to who the Building Code Official is per ACI 318 section 1 from a NextEra perspective.

-----Original Appointment-----
From: Willoughby, Paul
Sent: Thursday, December 20, 2012 1:39 PM
To: Willoughby, Paul; Noble, Rick; Vassallo, Theodore; Brown, Brian; OKeefe, Michael; Cliche, Richard; Conte, Richard; Cook, William; Raymond, William; Chaudhary, Suresh; Buford, Angela; Floyd, Niklas
Subject: NRC Conference Call - ASR
When: Wednesday, January 09, 2013 10:30 AM-11:30 AM (GMT-05:00) Eastern Time (US & Canada).
Where: OSB - Engineering Managers Conference Room (Tentative)

call in number 305-552-3000 passcode 7737745

Agenda:

1. Continue dialog on R&D for Shear and Lap-splice (CAL#8)
2. Continue dialog on R&D for Embedment and Anchor Bolt Testing (CAL#11):

3. Related question: Ted and Bill R. were to get together and ID spec for this – ID 66 and 67 on Certrec, ID Foreign Print?
4. In light of latest CAL letter to submit detailed plans by Feb. 28, 2013, how can you start testing in this area before then?

5. Any update to schedule completion for Phase III Walkdown and Baseline Primary Containment for ASR
6. Please ID dates for IAEA review to avoid inspection week conflicts – ASR group will most likely do last full week of the month starting Jan. 28 – we will need to coordinate on NRC teams also.
7. Chaudhary and Conte would like to go to U of T for a QA review on actions to date and familiarization visit the week of Jan. 22 – bad time? or is the week of Feb. 4 better – Suresh is unavailable the week of Jan. 14 and Jan 28.
8. Finally, when will the RCE revision (CAL # 2) be in.
9.

USNRC

In situ Monitoring of ASR-affected Concrete

A study on crack indexing and damage rating index to assess the severity of ASR and to monitor ASR progression

Angela Buford
11/21/2012

B2

Key Messages:

1. Surface cracking may not be indicative of the conditions of the concrete through the section, and crack indexing measurements may not consistently indicate the level of ASR severity from one structure to another. For each group of similar (i.e., reinforcement detail, size, environmental conditions) structures, additional examinations are necessary to correlate crack measurements to severity of ASR degradation.

2. Crack mapping results should be correlated to actual strains (and therefore stresses) in the concrete and rebar in order to accurately represent the effect of ASR-induced stresses in engineering evaluations for structural behavior.

3. Damage Rating Index (DRI) is a more accurate measure of ASR severity than crack indexing, and alleviates many of the pitfalls of the crack indexing method. DRI should be considered as a method to assess damage related to ASR.

Alkali-Silica Reaction (ASR)

ASR is a chemical reaction that occurs in concrete between alkali hydroxides dissolved in the cement pore solution and reactive silica phases in the aggregates. The product of the reaction is an expansive gel around the aggregate particles, which imbibes water from the pore fluid, and, having much larger volume than the reacting components, triggers a progressive damage of the material (Winnicki and Pietruszczak 2008). The pressures imparted by the gel onto the concrete can exceed the tensile strength of the aggregates and the cement paste and cause microcracking and macrocracking in the aggregate and surrounding paste. With the presence of moisture, the gel expands and can cause destructive cracking and deleterious expansion of the concrete. The extent of the concrete deterioration depends on aggregate reactivity, high levels of alkalinity, availability of moisture, temperature, and structural restraint (Williams, Choudhuri, and Perez 2009). Concrete expansion and cracking can lead to serious operational and serviceability problems in concrete structures (Rivard et al. 2002).

Surface Cracking and Expansion

The Federal Highway Administration (FHWA) Report on the Diagnosis, Prognosis, and Mitigation of Alkali-Silica Reaction in Transportation Structures states that "in concrete members undergoing internal expansion due to ASR and subject to wetting and drying cycles (cyclic exposure to sun, rain, wind, etc.), the concrete often shows surface cracking because of induced tension cracking in the 'less expansive' surface layer (because of variable humidity conditions and leaching of alkalis) under the expansive thrust of the inner concrete core (with more constant humidity and pH conditions)." Cracks first form as three or four-pronged star patterns resulting from expansion of the gel reacting with the aggregate. If the concrete is not subject to directional stress, the crack pattern developed forms irregular polygons, commonly referred to as map cracking (Swamy 1992). This cracking is usually enough to relieve the pressure and accommodate the resulting volume increase (Figg 1987; reported by Farny et. Al. 2007).

Map cracking is one of the most commonly reported visual signs associated with ASR. The pattern and severity of cracking vary depending on the type and quantity of reactive aggregate used, the alkali content of the concrete, exposure conditions, distribution of stresses, and degree of confinement in the concrete (Smaoui et al. 2004). ASR can also be characterized by longitudinal cracking, surface discoloration, aggregate pop-out, and surface deposits (gel or efflorescence) (Williams, Choudhuri, and Perez 2009). Although pattern cracking is a characteristic visual indication that ASR may be present in

the concrete, ASR can exist in concrete without indications of pattern cracking. Newman (2003) noted that "while superficial cracking patterns can often be reminiscent of ASR, it is important to be aware that reliable diagnosis can never be adequately based on the appearance of surface cracking alone." This consideration is also emphasized by Barnes (2001), whose research cites examples where cracking was thought to be and diagnosed as ASR, and also examples in which ASR gel and associated cracked aggregate particles were found in concrete that was uncracked. In addition, in ASR-affected structures with reinforcement close to the surface or in heavily reinforced structures, surface cracking may be suppressed while internal damage exists throughout the section. The presence and extent of surface cracking is not a conclusive indication that ASR is present or measure of concrete degradation due to ASR.

Crack Mapping/Indexing

In order to determine the effect of ASR on the performance of a concrete structure, it is important that there be an understanding of current concrete condition (ASR damage reached to-date) and the rate of expansion. Crack indexing is a method that is proposed to measure crack widths and expansion of cracks over time. For this visual examination individual crack widths are measured over a defined grid and the total amount of cracking is quantified. The examination is repeated over regular intervals and the results are compared over time, with a goal of establishing a rate of ASR progression. The Institute of Structural Engineers (ISE 1992) proposed a method for crack mapping that consists of measuring the ASR crack widths along five parallel lines that are each 1 m long. Lines are traced directly onto the concrete structure. The total width of intersecting cracks along each line is summed and divided by the length of the line to determine the severity of ASR cracking, and then over time to determine the rate of expansion. Another method, suggested by Laboratoire Central des Ponts et Chaussees (LCPC 1997) consists of measuring the widths of all cracks intersecting two perpendicular 1m lines originating from the same point and their two diagonals 1.4 m long. The total crack index is determined as a value in millimeters per meter and compared to criteria that correspond to action levels.

Summary of General Discussion on Crack Mapping

It is stated throughout ASR research that crack mapping is somewhat limited in its applicability. Saint-Pierre et al. (2007) note that compared to other non-destructive methods developed for assessing the damage induced by ASR, the semi-quantitative surface methods like crack mapping appear to be less effective. It is generally agreed that while results of crack indexing can potentially give some indication of how ASR is progressing over time, establishing an absolute trend that directly correlates expansion levels to ASR progression may not be a reliable practice. ASR research also indicates that using crack measurement alone to characterize the current state of ASR degradation would not be advised, since the practice relies on the assumption that the surface cracking on the face of a structure is wholly congruent to ASR severity. In the 2010 Addendum to its report titled "Structural Effects of Alkali-Silica Reaction - Technical guidance on the Appraisal of Existing Structures," ISE stated that the crack summation procedures for estimating expansion to date work well in directions where there is little restraint from structural stress, reinforcement, or prestress. This suggests that in structures with higher restraint, this would not be the case. In addition, crack mapping is limited in that it can only give data on two-way crack measurements and does not capture cracking in the out-of-plane direction. It is suggested that further activities be carried out for assessing current condition of the concrete and current expansion rate, as well as correlating the expansion to structural integrity.

In addition, crack indexing evaluation criteria should not be universally applied to all structures because surface cracking may not give a reliable indication of the ASR degradation to the structure. Due to

variability in size, location, environment, reinforcement detailing, and relative severity of ASR damage, it may be necessary to obtain an understanding of the ASR effects for each individual structure or group of structures with similar physical properties and environments. Indeed, Newman (2003) stated "it is important to relate cracking patterns variously to structural geometry and/or design, apparent concreting sequence, localized detailing (especially where cracking may be coincident with water leakage) and both environmental and in-service conditions."

Surface Cracking vs. Internal ASR Damage

The correlation between surface cracking and ASR deterioration may be closer to unity for specimens used in the laboratory that are only allowed to deteriorate due to ASR conditions. However, for concrete in the field, the surface indications sometimes poorly correlate to the extent of ASR degradation within the concrete. Since conditions are so variable from one region to another, and even from one place to another in the same structure, poor correlations are often observed between the severity of surface cracking and the presence of the internal signs of ASR (i.e., reaction products, micro-cracking, and expansion) (Nishibayashi et al. 1989 and Stark 1990 reported by Smaoui et al. 2002). Development of cracking on the surface depends strongly on the amount of reinforcement close to the surface (Smaoui et al. 2002) and also depends on external environmental conditions such as wetting-drying, freezing-thawing, and exposure to saline solutions (Smaoui et al. 2002). Two examples of situations in which external conditions can affect the surface cover concrete such that the surface features are not indicative of the actual ASR degradation of the structure are presented here for consideration. In one case, presence and extent of surface cracking can depend on the pH of the surface which can be affected by leaching and carbonation. As such, wetting-drying cycles can affect the features of ASR, as conditions at the surface layer could be less favorable to the development of ASR, due to the [lower] humidity during the drying periods and the leaching of alkalis during the wetting periods (Poitevin 1983 and Swamy 1995, reported by Smaoui et al. 2004). In other words, if the outer surface layer of concrete is exposed to conditions that would cause the ASR severity or development to be lower, but conditions inside the concrete remain conducive to ASR development (i.e., high relative humidity); surface conditions would not be representative of the ASR within the concrete section. Crack indexing efforts would incorrectly characterize the level of ASR degradation as minor, when within the section the ASR degradation might be more severe.

Another example in which environmental conditions have caused surface conditions to be different than conditions within the concrete is the subject of a study done by Berube et al (2002). In this study, an attempt was made to correlate ASR expansion with type of exposure to moisture. Results showed that in specimens exposed to wetting-drying cycles saw more surface cracking but less actual expansion than specimens that were always exposed to humidity. In this case, the larger amount of surface cracking evident in the specimens exposed to wetting-drying cycles did not show to correlate well to the actual expansion due to ASR; with the ASR expansion being less severe than the cracking would indicate. Conversely (and perhaps more ominously), the specimens that showed less surface cracking saw a greater expansion due to ASR, which shows that visual examination of surface cracking alone may not be adequate.

Smaoui et al. (2004) state that although the intensity of surface cracking on ASR-affected concrete in service can help to assess the severity of ASR, quantitative measurement of this intensity [i.e., crack mapping] [could] lead to values that generally underestimate the true expansion attained, except maybe when the surface concrete layer does not suffer any ASR expansion at all. If the concrete surface layer undergoes ASR expansion that is less than that of the inner concrete, according to Smaoui et al. (2004), "the measurement of surface cracking will tend to give expansion values lower than the overall expansion

of the concrete element under study." This research indicates that the degree of correlation between surface cracking and actual ASR expansion or degradation tends to vary with the level of exposure, which means that crack indexing over a number of structures with varying environmental conditions may not conclusively measure the extent or severity of ASR degradation. It should also be noted here that periodic crack indexing measurements also have the potential to be misleading since crack sizes can vary seasonally.

ASR-induced Stresses

The ISE (2010) noted that for some structures exposed to ASR, internal damage occurs through the depth [of the section] but visible cracking is suppressed by heavy reinforcement. In reinforced concrete structures, expansion of ASR cracks generates tensile stresses in the reinforcing steel while also causing compressive stresses in the concrete surrounding the rebar (this phenomenon is often likened to prestress in the concrete and noted to temporarily improve structural behavior). According to Smaoui et al., 2004, the most useful information in the structural evaluation of an ASR-affected concrete member is the state of the stresses in the concrete, but more importantly in the steel reinforcement. The ASR-induced stresses increase the structural demand on the steel and concrete, but this new design load has likely not been accounted for in the original design or in further structural evaluations. According to Multon et al. (2005), "assessment models have to take into consideration the property of stresses to modify ASR-induced expansions and their effect on the mechanical response of ASR-damaged structures..." Crack mapping alone to determine ASR effects on the structure does not allow for the consideration of rebar stresses. Visual examination and measurement of crack growth should be correlated to strain measurements taken of ASR-affected concrete and the reinforcing steel. In similar structures, then, the visual indications of expansion due to ASR can relate to stresses in the concrete and reinforcing steel in order to apply ASR-induced stress as an additional load in structural evaluations. Smaoui et al., 2004 propose that if it is not possible to do a destructive examination (i.e., exposing the rebar or taking deep cores) of the structure in question, "an indirect method is based on the expansion accumulated to date...Assuming that this expansion corresponds to that of the reinforcement steel, the stresses within the reinforcement and the concrete could thus be determined from the modulus of elasticity of the steel and the corresponding sections of the concrete elements under investigation." For determining added stresses in in situ structures, once correlation has been made with respect to size and rebar configuration between the in situ structure and a test specimen, it would be appropriate to use crack mapping as a measure of ASR degradation when introducing the additional ASR-induced stresses on concrete and reinforcing steel in structural evaluations.

Discussion on Applicability of Crack Indexing

This report is not intended to present the position that crack indexing and resulting data should not be part of a structural monitoring program to assess the ongoing effects of ASR in concrete. In fact, crack indexing is recommended by the Federal Highway Administration (FHWA 2010) "to obtain a quantitative rating of the 'surface' deterioration of the structure as a whole" (it should be noted that in the FHWA document, the word "surface" is emphasized with quotation marks, which implies recognition that crack indexing measurements alone provide information limited only to what is occurring at the concrete surface). This report's position is that crack mapping can only be useful once there is an understanding of how the conditions inside the concrete, (i.e., relative humidity, presence and severity of cracking, and added stresses in the concrete, reinforcing detail) correlate to the cracking observed at the surface. The FHWA (2010) document agrees, indicating that to obtain an understanding of the current state of ASR degradation and in order to correlate the surface cracking to the actual effects of ASR-induced expansion on the structure, other investigations of the in-situ structure are necessary. In addition to crack indexing,

FHWA recommendations that apply to nuclear structures include taking stress [strain] measurements in reinforcing steel, obtaining temperature and humidity readings, and performing non-destructive testing such as pulse velocity measurements (the recommendation to use pulse velocity measurements is in agreement with the experimental findings of Saint-Pierre et al. 2007). The Institution of Structural Engineers (ISE 2010) suggests that expansion to date and severity of ASR should be evaluated using examination and testing of cores for changes in modulus of elasticity and development of hysteresis (stiffness deterioration). It is also proposed that strain sensors be used as a method of monitoring ASR progression (Harries 2012) in order to monitor and quantify out-of-plane expansion.

In addition to provisions for monitoring (or predicting) progression of ASR, it is recommended that each structure or group of similar structures undergo petrographic analysis to determine the current state of ASR damage, in order to provide an accurate baseline from which to understand the current severity level and monitor ASR progression. A discussion of the Damage Rating Index method for assessing ASR severity is discussed in Appendix A of this report.

Appendix A: Damage Rating Index

The damage rating index (DRI) was developed by Grattan-Bellew and Danay in 1992 (Reported by Smaoui et al. 2004) as a method to determine the extent of internal damage in concrete affected by ASR (Rivard et al. 2002). The DRI is a method for quantifying both qualitative and quantitative observations and determining severity of ASR using petrographic analysis of polished sections of concrete. It is based on the recognition of a series of petrographic features that are commonly associated with ASR (Rivard et al. 2002). The DRI accounts for defects observed in the concrete, such as the presence and distribution of reaction products, existence of internal microcracking, and location of microcracking (within the aggregate vs. through the cement paste) by assigning a weighting factor to each and quantifying overall damage. When the factors are normalized to an area of 100 cm^2, the resulting number is the DRI. Rivard et. Al. (2000) noted that the abundance of individual defects and the overall DRI values increased with regularity with increased ASR expansion. It should be noted that the specimens used by Rivard et. Al. were comprised of reactive aggregates with different reaction mechanisms, but ASR expansion indeed correlated with DRI measures of ASR severity. Rivard et al. noted a possible limitation of the DRI method: that weighting factors assigned to each defect may not universally apply to all types of reactive aggregates (reported by Smaoui et al. 2004) and that weighting factor adjustments may be appropriate depending on the aggregate being examined. Other than that, research supports that this method is a more effective way to assess severity of ASR than crack indexing.

Smaoui et al. (2004) performed damage rating indexing on specimens from five concrete mixes using different reactive aggregates to determine if there was a reliable and accurate correlation between ASR damage determined by DRI and ASR expansion measurements. They noted that there exists a potential error in estimating expansion of ASR concrete in the field and establishing a DRI-expansion relationship with laboratory testing. In some of the lab specimens, relatively similar DRI values were obtained for very different expansion levels for cylinders which had been cast with the same concrete mix (and progressed ASR over time). The tests indicated that expansion levels (of in situ structures compared to laboratory specimens) may not be the best indication of ASR degradation. For example, the presence of air bubbles in the proximity of reactive aggregates [in field concrete] usually has the effect of reducing the expansion due to ASR (Landry 1994, Reported by Smaoui et al. 2004). In other words, air bubbles that exist in the in situ concrete structure could result in a smaller expansion of the structure as concluded under crack mapping activities while more severe ASR damage could be present in the structure because ASR features have "room" to grow inside the existing structure before extensive cracking is notable on the concrete surface. Smaoui et al. (2004) concluded that "for evaluating the expansion attained to date by ASR-affected concrete, it may be necessary to reconsider the relevant defects and their respective weighting factors and take into account a certain number of factors such as the presence or absence of entrained air and preexisting cracks and alteration rims" to assess the severity of ASR in structures. It is notable that the research done by Rivard et al. (2000) showed that DRI correlated well with actual ASR expansion, while subsequent work done by Smaoui et al. (2004) proposed that in some cases lack of gross expansion did not correlate to low ASR degradation, and that air bubbles prevented macro-level expansion even though ASR effects were severe. Crack indexing would not have identified this severe ASR progression since that method only measures expansion of cracks.

The DRI has been shown to be a relatively inexpensive and effective method for assessing the damage level of ASR-affected structures.

References

(coming soon)

USNRC

In situ Monitoring of ASR-affected Concrete

A study on crack indexing and damage rating index to assess the severity of ASR and to monitor ASR progression

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11/21/2012

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Key Messages:

1. Three or four pronged surface cracking (map cracking) in concrete structures may be indicative of ASR .
2. Presence of ASR in concrete structures can only be confirmed or ruled out by petrographic examination of concrete cores extracted from affected structure.
3. The width and extent of surface cracking (crack mapping) cannot by itself used to determine the degradation and loss of strength in concrete structures.
   Laboratory and in-situ testing must be performed to correlate Surface cracking with loss of mechanical properties because cracking patterns may vary for different structural geometry and/or design, apparent concreting sequence, localized detailing (especially where cracking may be coincident with water leakage) and both environmental and in-service conditions."
4. Damage Rating Index (DRI) is a more accurate measure of ASR severity than crack indexing, and alleviates many of the pitfalls of the crack indexing method. DRI should be considered as a method to assess damage related to ASR.

Deleted: may not be indicative of the conditions of the concrete through the section, and crack indexing measurements may not consistently indicate the level of ASR severity from one structure to another. For each group of similar (i.e., reinforcement detail, size, environmental conditions) structures, additional examinations are necessary to correlate crack measurements to severity of ASR degradation.¶
<#>¶
<#>Crack mapping results should be correlated to actual strains (and therefore stresses) in the concrete and rebar in order to accurately represent the effect of ASR-induced stresses in engineering evaluations for structural behavior.¶

Alkali-Silica Reaction (ASR)

ASR is a chemical reaction that occurs in concrete between alkali hydroxides dissolved in the cement pore solution and reactive silica phases in the aggregates. The product of the reaction is an expansive gel around the aggregate particles, which imbibes water from the pore fluid, and, having much larger volume than the reacting components, triggers a progressive damage of the material (Winnicki and Pietruszczak 2008). The pressures imparted by the gel onto the concrete can exceed the tensile strength of the aggregates and the cement paste and cause microcracking and macrocracking in the aggregate and surrounding paste. With the presence of moisture, the gel expands and can cause destructive cracking and deleterious expansion of the concrete. The extent of the concrete deterioration depends on aggregate reactivity, high levels of alkalinity, availability of moisture, temperature, and structural restraint (Williams, Choudhuri, and Perez 2009). Concrete expansion and cracking can lead to serious operational and serviceability problems in concrete structures (Rivard et al. 2002).

Surface Cracking and Expansion

The Federal Highway Administration (FHWA) Report on the Diagnosis, Prognosis, and Mitigation of Alkali-Silica Reaction in Transportation Structures states that "in concrete members undergoing internal expansion due to ASR and subject to wetting and drying cycles (cyclic exposure to sun, rain, wind, etc.), the concrete often shows surface cracking because of induced tension cracking in the 'less expansive' surface layer (because of variable humidity conditions and leaching of alkalis) under the expansive thrust of the inner concrete core (with more constant humidity and pH conditions)." Cracks first form as three or four-pronged star patterns resulting from expansion of the gel reacting with the aggregate. If the concrete is not subject to directional stress, the crack pattern developed forms irregular polygons, commonly referred to as map cracking (Swamy 1992). This cracking is usually enough to relieve the pressure and accommodate the resulting volume increase (Figg 1987; reported by Farny et. Al. 2007).

Map cracking is one of the most commonly reported visual signs associated with ASR. The pattern and severity of cracking vary depending on the type and quantity of reactive aggregate used, the alkali content of the concrete, exposure conditions, distribution of stresses, and degree of confinement in the concrete (Smaoui et al. 2004). ASR can also be characterized by longitudinal cracking, surface discoloration, aggregate pop-out, and surface deposits (gel or efflorescence) (Williams, Choudhuri, and Perez 2009). Although pattern cracking is a characteristic visual indication that ASR may be present in

the concrete, ASR can exist in concrete without indications of pattern cracking. Newman (2003) noted that "while superficial cracking patterns can often be reminiscent of ASR, it is important to be aware that reliable diagnosis can never be adequately based on the appearance of surface cracking alone." This consideration is also emphasized by Barnes (2001), whose research cites examples where cracking was thought to be and diagnosed as ASR, and also examples in which ASR gel and associated cracked aggregate particles were found in concrete that was uncracked. In addition, in ASR-affected structures with reinforcement close to the surface or in heavily reinforced structures, surface cracking may be suppressed while internal damage exists throughout the section. The presence and extent of surface cracking is not a conclusive indication that ASR is present or measure of concrete degradation due to ASR.

Crack Mapping/Indexing

In order to determine the effect of ASR on the performance of a concrete structure, it is important that there be an understanding of current concrete condition (ASR damage reached to-date) and the rate of expansion. Crack indexing is a method that is proposed to measure crack widths and expansion of cracks over time. For this visual examination individual crack widths are measured over a defined grid and the total amount of cracking is quantified. The examination is repeated over regular intervals and the results are compared over time, with a goal of establishing a rate of ASR progression. The Institute of Structural Engineers (ISE 1992) proposed a method for crack mapping that consists of measuring the ASR crack widths along five parallel lines that are each 1 m long. Lines are traced directly onto the concrete structure. The total width of intersecting cracks along each line is summed and divided by the length of the line to determine the severity of ASR cracking, and then over time to determine the rate of expansion. Another method, suggested by Laboratoire Central des Ponts et Chaussees (LCPC 1997) consists of measuring the widths of all cracks intersecting two perpendicular 1m lines originating from the same point and their two diagonals 1.4 m long. The total crack index is determined as a value in millimeters per meter and compared to criteria that correspond to action levels.

Summary of General Discussion on Crack Mapping

It is stated throughout ASR research that crack mapping is somewhat limited in its applicability. Saint-Pierre et al. (2007) note that compared to other non-destructive methods developed for assessing the damage induced by ASR, the semi-quantitative surface methods like crack mapping appear to be less effective. It is generally agreed that while results of crack indexing can potentially give some indication of how ASR is progressing over time, establishing an absolute trend that directly correlates expansion levels to ASR progression may not be a reliable practice. ASR research also indicates that using crack measurement alone to characterize the current state of ASR degradation would not be advised, since the practice relies on the assumption that the surface cracking on the face of a structure is wholly congruent to ASR severity. In the 2010 Addendum to its report titled "Structural Effects of Alkali-Silica Reaction - Technical guidance on the Appraisal of Existing Structures," ISE stated that the crack summation procedures for estimating expansion to date work well in directions where there is little restraint from structural stress, reinforcement, or prestress. This suggests that in structures with higher restraint, this would not be the case. In addition, crack mapping is limited in that it can only give data on two-way crack measurements and does not capture cracking in the out-of-plane direction. It is suggested that further activities be carried out for assessing current condition of the concrete and current expansion rate, as well as correlating the expansion to structural integrity.

In addition, crack indexing evaluation criteria should not be universally applied to all structures because surface cracking may not give a reliable indication of the ASR degradation to the structure. Due to

variability in size, location, environment, reinforcement detailing, and relative severity of ASR damage, it may be necessary to obtain an understanding of the ASR effects for each individual structure or group of structures with similar physical properties and environments. Indeed, Newman (2003) stated "it is important to relate cracking patterns variously to structural geometry and/or design, apparent concreting sequence, localized detailing (especially where cracking may be coincident with water leakage) and both environmental and in-service conditions."

Surface Cracking vs. Internal ASR Damage

The correlation between surface cracking and ASR deterioration may be closer to unity for specimens used in the laboratory that are only allowed to deteriorate due to ASR conditions. However, for concrete in the field, the surface indications sometimes poorly correlate to the extent of ASR degradation within the concrete. Since conditions are so variable from one region to another, and even from one place to another in the same structure, poor correlations are often observed between the severity of surface cracking and the presence of the internal signs of ASR (i.e., reaction products, micro-cracking, and expansion) (Nishibayashi et al. 1989 and Stark 1990 reported by Smaoui et al. 2002). Development of cracking on the surface depends strongly on the amount of reinforcement close to the surface (Smaoui et al. 2002) and also depends on external environmental conditions such as wetting-drying, freezing-thawing, and exposure to saline solutions (Smaoui et al. 2002). Two examples of situations in which external conditions can affect the surface cover concrete such that the surface features are not indicative of the actual ASR degradation of the structure are presented here for consideration. In one case, presence and extent of surface cracking can depend on the pH of the surface which can be affected by leaching and carbonation. As such, wetting-drying cycles can affect the features of ASR, as conditions at the surface layer could be less favorable to the development of ASR, due to the [lower] humidity during the drying periods and the leaching of alkalis during the wetting periods (Poitevin 1983 and Swamy 1995, reported by Smaoui et al. 2004). In other words, if the outer surface layer of concrete is exposed to conditions that would cause the ASR severity or development to be lower, but conditions inside the concrete remain conducive to ASR development (i.e., high relative humidity); surface conditions would not be representative of the ASR within the concrete section. Crack indexing efforts would incorrectly characterize the level of ASR degradation as minor, when within the section the ASR degradation might be more severe.

Another example in which environmental conditions have caused surface conditions to be different than conditions within the concrete is the subject of a study done by Berube et al (2002). In this study, an attempt was made to correlate ASR expansion with type of exposure to moisture. Results showed that in specimens exposed to wetting-drying cycles saw more surface cracking but less actual expansion than specimens that were always exposed to humidity. In this case, the larger amount of surface cracking evident in the specimens exposed to wetting-drying cycles did not show to correlate well to the actual expansion due to ASR, with the ASR expansion being less severe than the cracking would indicate. Conversely (and perhaps more ominously), the specimens that showed less surface cracking saw a greater expansion due to ASR, which shows that visual examination of surface cracking alone may not be adequate.

Smaoui et al. (2004) state that although the intensity of surface cracking on ASR-affected concrete in service can help to assess the severity of ASR, quantitative measurement of this intensity [i.e., crack mapping] [could] lead to values that generally underestimate the true expansion attained, except maybe when the surface concrete layer does not suffer any ASR expansion at all. If the concrete surface layer undergoes ASR expansion that is less than that of the inner concrete, according to Smaoui et al. (2004), "the measurement of surface cracking will tend to give expansion values lower than the overall expansion

of the concrete element under study." This research indicates that the degree of correlation between surface cracking and actual ASR expansion or degradation tends to vary with the level of exposure, which means that crack indexing over a number of structures with varying environmental conditions may not conclusively measure the extent or severity of ASR degradation. It should also be noted here that periodic crack indexing measurements also have the potential to be misleading since crack sizes can vary seasonally.

ASR-induced Stresses

The ISE (2010) noted that for some structures exposed to ASR, internal damage occurs through the depth [of the section] but visible cracking is suppressed by heavy reinforcement. In reinforced concrete structures, expansion of ASR cracks generates tensile stresses in the reinforcing steel while also causing compressive stresses in the concrete surrounding the rebar (this phenomenon is often likened to prestress in the concrete and noted to temporarily improve structural behavior). According to Smaoui et al., 2004, the most useful information in the structural evaluation of an ASR-affected concrete member is the state of the stresses in the concrete, but more importantly in the steel reinforcement. The ASR-induced stresses increase the structural demand on the steel and concrete, but this new design load has likely not been accounted for in the original design or in further structural evaluations. According to Multon et al. (2005), "assessment models have to take into consideration the property of stresses to modify ASR-induced expansions and their effect on the mechanical response of ASR-damaged structures..." Crack mapping alone to determine ASR effects on the structure does not allow for the consideration of rebar stresses. Visual examination and measurement of crack growth should be correlated to strain measurements taken of ASR-affected concrete and the reinforcing steel. In similar structures, then, the visual indications of expansion due to ASR can relate to stresses in the concrete and reinforcing steel in order to apply ASR-induced stress as an additional load in structural evaluations. Smaoui et al., 2004 propose that if it is not possible to do a destructive examination (i.e., exposing the rebar or taking deep cores) of the structure in question, "an indirect method is based on the expansion accumulated to date...Assuming that this expansion corresponds to that of the reinforcement steel, the stresses within the reinforcement and the concrete could thus be determined from the modulus of elasticity of the steel and the corresponding sections of the concrete elements under investigation." For determining added stresses in in situ structures, once correlation has been made with respect to size and rebar configuration between the in situ structure and a test specimen, it would be appropriate to use crack mapping as a measure of ASR degradation when introducing the additional ASR-induced stresses on concrete and reinforcing steel in structural evaluations.

Discussion on Applicability of Crack Indexing

This report is not intended to present the position that crack indexing and resulting data should not be part of a structural monitoring program to assess the ongoing effects of ASR in concrete. In fact, crack indexing is recommended by the Federal Highway Administration (FHWA 2010) "to obtain a quantitative rating of the 'surface' deterioration of the structure as a whole" (it should be noted that in the FHWA document, the word "surface" is emphasized with quotation marks, which implies recognition that crack indexing measurements alone provide information limited only to what is occurring at the concrete surface). This report's position is that crack mapping can only be useful once there is an understanding of how the conditions inside the concrete, (i.e., relative humidity, presence and severity of cracking, and added stresses in the concrete, reinforcing detail) correlate to the cracking observed at the surface. The FHWA (2010) document agrees, indicating that to obtain an understanding of the current state of ASR degradation and in order to correlate the surface cracking to the actual effects of ASR-induced expansion on the structure, other investigations of the in-situ structure are necessary. In addition to crack indexing,

FHWA recommendations that apply to nuclear structures include taking stress [strain] measurements in reinforcing steel, obtaining temperature and humidity readings, and performing non-destructive testing such as pulse velocity measurements (the recommendation to use pulse velocity measurements is in agreement with the experimental findings of Saint-Pierre et al. 2007). The Institution of Structural Engineers (ISE 2010) suggests that expansion to date and severity of ASR should be evaluated using examination and testing of cores for changes in modulus of elasticity and development of hysteresis (stiffness deterioration). It is also proposed that strain sensors be used as a method of monitoring ASR progression (Harries 2012) in order to monitor and quantify out-of-plane expansion.

In addition to provisions for monitoring (or predicting) progression of ASR, it is recommended that each structure or group of similar structures undergo petrographic analysis to determine the current state of ASR damage, in order to provide an accurate baseline from which to understand the current severity level and monitor ASR progression. A discussion of the Damage Rating Index method for assessing ASR severity is discussed in Appendix A of this report.

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Appendix A: Damage Rating Index

The damage rating index (DRI) was developed by Grattan-Bellew and Danay in 1992 (Reported by Smaoui et al. 2004) as a method to determine the extent of internal damage in concrete affected by ASR (Rivard et al. 2002). The DRI is a method for quantifying both qualitative and quantitative observations and determining severity of ASR using petrographic analysis of polished sections of concrete. It is based on the recognition of a series of petrographic features that are commonly associated with ASR (Rivard et al. 2002). The DRI accounts for defects observed in the concrete, such as the presence and distribution of reaction products, existence of internal microcracking, and location of microcracking (within the aggregate vs. through the cement paste) by assigning a weighting factor to each and quantifying overall damage. When the factors are normalized to an area of 100 cm^2, the resulting number is the DRI. Rivard et. Al. (2000) noted that the abundance of individual defects and the overall DRI values increased with regularity with increased ASR expansion. It should be noted that the specimens used by Rivard et. Al. were comprised of reactive aggregates with different reaction mechanisms, but ASR expansion indeed correlated with DRI measures of ASR severity. Rivard et al. noted a possible limitation of the DRI method: that weighting factors assigned to each defect may not universally apply to all types of reactive aggregates (reported by Smaoui et al. 2004) and that weighting factor adjustments may be appropriate depending on the aggregate being examined. Other than that, research supports that this method is a more effective way to assess severity of ASR than crack indexing.

Smaoui et al. (2004) performed damage rating indexing on specimens from five concrete mixes using different reactive aggregates to determine if there was a reliable and accurate correlation between ASR damage determined by DRI and ASR expansion measurements. They noted that there exists a potential error in estimating expansion of ASR concrete in the field and establishing a DRI-expansion relationship with laboratory testing. In some of the lab specimens, relatively similar DRI values were obtained for very different expansion levels for cylinders which had been cast with the same concrete mix (and progressed ASR over time). The tests indicated that expansion levels (of in situ structures compared to laboratory specimens) may not be the best indication of ASR degradation. For example, the presence of air bubbles in the proximity of reactive aggregates [in field concrete] usually has the effect of reducing the expansion due to ASR (Landry 1994, Reported by Smaoui et al. 2004). In other words, air bubbles that exist in the in situ concrete structure could result in a smaller expansion of the structure as concluded under crack mapping activities while more severe ASR damage could be present in the structure because ASR features have "room" to grow inside the existing structure before extensive cracking is notable on the concrete surface. Smaoui et al. (2004) concluded that "for evaluating the expansion attained to date by ASR-affected concrete, it may be necessary to reconsider the relevant defects and their respective weighting factors and take into account a certain number of factors such as the presence or absence of entrained air and preexisting cracks and alteration rims" to assess the severity of ASR in structures. It is notable that the research done by Rivard et al. (2000) showed that DRI correlated well with actual ASR expansion, while subsequent work done by Smaoui et al. (2004) proposed that in some cases lack of gross expansion did not correlate to low ASR degradation, and that air bubbles prevented macro-level expansion even though ASR effects were severe. Crack indexing would not have identified this severe ASR progression since that method only measures expansion of cracks.

The DRI has been shown to be a relatively inexpensive and effective method for assessing the damage level of ASR-affected structures.

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References

(coming soon)

You mix water, cement, and aggregate to make concrete. ~~Fire~~ Oil and water certainly ~~don't~~ do not mix, but concrete and water ~~don't~~ do not make for a very good combination, either.

In the case of the Seabrook nuclear power plant, the intrusion of moisture into the foundation walls of certain structures at the New Hampshire facility has been a source of concern after it triggered the degradation of some of the concrete there.

The exact term for what is occurring at Seabrook is alkali silica reaction, or ASR, which involves the hydroxide ions in the pore solution in cement paste and the reactive silica in aggregate. The main byproduct of ASR is a gel, which can expand and generate significant interface pressure and may cause micro-cracks in the concrete.

While the extent of the problem is still being evaluated, the NRC has classified the walls for now as "operable but degraded."

What exactly does that mean? In layman's terms, it means the NRC – while far from done with reviews of the issue – has determined the structures can continue to safely perform their function based on the following information: 1.) conservative safety load factors, or additional design margin included when the structures were designed and built; 2.) field walkdowns (visual observations by qualified inspectors); 3.) the fact that the ASR is limited to localized areas; and 4.) because progression of the concrete degradation is occurring slowly.

That determination, contained in an NRC inspection report issued on March 26, 2012, was the result of reviews carried out by six of our inspectors over many months, dating back to last September. Among other things, we made use of concrete/structural integrity expertise at our Headquarters office. We also had an inspector in our Region III Office, in suburban Chicago, office observe lab tests performed in Northfield, Ill., on concrete core samples taken from Seabrook.

An important next step for the NRC's review of the Seabrook concrete degradation will be a public meeting scheduled for Monday, April 23, 2012, at our Headquarters office in Rockville, Md. During that meeting, the NRC staff will discuss the results of evaluations done to date; a ~~comprehensive~~ plan developed by NextEra, the plant's owner and operator, to address the condition; and other details.

Based on the outcome of that session, the NRC will determine its next steps regarding the issue. One thing we have already made clear is that no decision will be made by the agency on a license renewal application for the plant until the extent of the concrete degradation is fully understood.

Members of the public who would like to observe the meeting but cannot travel to NRC Headquarters for it will be able to listen in by phone bridge. What's more, the slides to be used during the session will be available via the Go2Meeting program.

More details regarding the April 23rd meeting is available at: http://www.nrc.gov/public-involve/public-meetings/index.cfm .

Seabrook ASR – Regulatory Process Overview and Approach

1. The licensee has performed an operability determination and is currently tracking this issue as a degraded or noncomforming condition in accordance with their corrective action program. The U.S. Nuclear Regulatory Commission (NRC) staff's review of alkali-silica reaction (ASR) issue to date has determined that there are no immediate safety concerns due, in part, to existing safety margins, the localized nature of the ASR, and ongoing crack monitoring. In Inspection Report, dated December 3, 2012, "The NRC determined that NextEra's methods for assessing operability of ASR-affected reinforced concrete structures were reasonable and generally comprehensive. NextEra conducted a margins analysis, using bounding ASR-affected concrete properties derived from research data, to demonstrate that Seabrook structures remained operable. The [NRC] team concluded this margins assessment provided a reasonable operability basis and noted that further testing and engineering analyses are planned by NextEra to address this reinforced concrete structures non-conforming condition. The testing and additional analyses are expected to be completed by mid-2014."
2. Seabrook submitted evaluation/analysis in accordance with the Confirmatory Action Letter (CAL) on May 25, 2012.
   2.1. Evaluation of impact of ASR on Seabrook constitutes an analysis performed at NRC request.
   2.2. 10 CFR 50.71(e) requires the Final Safety Analysis Report (FSAR) to be updated with "...all analyses of new safety issues performed by or on behalf of the applicant or licensee at Commission request."
   2.3. The FSAR update must, "...assure that the information included in the report contains the latest information developed. This submittal shall contain all the changes necessary to reflect information and analyses submitted to the Commission by the ... licensee ..."
3. Therefore, NextEra is required to incorporate this information into the FSAR in accordance with 10 CFR 50.71(e)(4).
   3.1. Based on the May 25, 2012 submittal, this FSAR update must be submitted no later than November 17, 2013. Licensee is working on update and plans to submit in May 2013.
   3.2. The change to the FSAR must be evaluated in accordance with 10 CFR 50.59 to determine if NRC approval is required prior to incorporation into the FSAR update.
4. The 10 CFR 50.59 evaluation of the FSAR update may trigger a request for amendment pursuant to 10 CFR 50.90. This evaluation is made by the licensee and is subject to NRC review and /or inspection.
   4.1. Amendment process provides a strong regulatory framework to document NRC staff review of the licensee evaluation/analysis of ASR.
   4.2. Amendment process provides a structured opportunity for public involvement.
   4.3. An amendment could be structured to provide license conditions that track future milestones toward permanent resolution of the issue.
5. Licensee final disposition of the degraded/nonconforming condition will likely require additional changes to the facility as described in the FSAR after the large scale testing is completed in mid-2014. Once again, the licensee needs to perform a 10 CFR 50.59 evaluation and determine if an amendment request is needed pursuant to 10 CFR 50.90.

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MEMORANDUM TO: Those on Attached List

FROM: Eric J. Leeds, Director
Office of Nuclear Reactor Regulation (NRR)

William M. Dean, Regional Administrator
Region I

SUBJECT: SEABROOK ASR ISSUE TECHNICAL TEAM CHARTER

The Seabrook Station, Unit 1 (Seabrook) Alkali-Silica Reaction (ASR) Issue Technical Team (SAITT) is hereby established. Under the enclosed charter, the SAITT will be responsible for providing the necessary oversight of all activities associated with the ASR issue.

Docket No. 50-443

Enclosure:
SAITT Charter

CONTACT: Meena Khanna, NRR/DORL
301-415-2150

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Office of Nuclear Reactor Regulation (NRR)

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Docket No. 50-443

Enclosure:
SAITT Charter

CONTACT: Meena Khanna, NRR/DORL
301-415-2150

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ADDRESSEES – Memorandum dated _____:

Region I

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Patrick Hiland, Director, Division of Engineering (DE)

Brian Holian, Director, Division of License Renewal (DLR)

CHARTER FOR THE

SEABROOK ASR ISSUE TECHNICAL TEAM

1. **THE GROUP'S OFFICIAL DESIGNATION:**

Seabrook Station, Unit 1 (Seabrook) Alkali-Silica Reaction (ASR) Issue Technical Team (SAITT).

2. **THE GROUP'S OBJECTIVE, BACKGROUND, REGULTORY FRAMEWORK, AND SCOPE OF ACTIVITIES:**

SAITT Authorization

This charter establishes and defines the responsibilities for the SAITT as it relates to the regulatory actions associated with the ASR issue at Seabrook.

Objective

The SAITT will provide oversight and coordination of the technical support of ongoing inspection activities concerning ASR issues identified at Seabrook.

Background

ASR is a slow chemical process that can occur over time in hardened concrete. The reaction requires reactive aggregate, high alkali content in cement, and adequate moisture to form a gel that expands and results in a network of microcracks.

ASR can impact the mechanical properties of concrete (compressive, tensile, shear, and bond strengths, and elastic modulus) used in design, and can also affect empirical code relationships between mechanical properties.

In August 2010, Seabrook reported the presence of ASR degradation of concrete in below-grade walls of several Category 1 structures with groundwater intrusion. Seabrook is the first plant to report ASR in the U.S. nuclear industry. Initial testing of core samples indicated a reduction in compressive strength and elastic modulus properties. The U.S. Nuclear Regulatory Commission (NRC) issued Information Notice (IN) 2011-20 on November 18, 2011, to provide the industry with information related to the ASR identified at Seabrook.

The NRC staff's review of this issue to date has determined that there are no immediate safety concerns due, in part, to existing safety margins, the localized nature of the ASR, and ongoing crack monitoring.

Regulatory Framework

Region I conducted several inspections and issued the following the inspection reports:

1. Feeder to Seabrook Report No. 05000443/2010004, dated September 29, 2010 (ADAMS Accession No. ML102730210);
2. Feeder to Seabrook Report No. 05000443/2010005, dated November 9, 2010 (ADAMS Accession No. ML103140182);
3. Feeder to Seabrook Report No. 05000443/2010005, dated December 17, 2010 (ADAMS Accession No. ML103510519);
4. Feeder to Seabrook Report No. 05000443/2011002, dated February 9, 2011 (ADAMS Accession No. ML110400676);
5. NRC Integrated Inspection Report 05000443/2011003, dated August 12, 2011 (ADAMS Accession No. ML112241543); and,
6. NRC Inspection Report 05000443/2011010 Related to Alkali-Silica Reaction Issue in Safety-Related Structures, dated March 26, 2012 (ADAMS Accession No. ML120480066).

The NRC report, dated March 26, 2012, documented two NRC-identified findings of very low significance (Green), one of which involved a violation of NRC requirements. Because of the very low safety significance, and because they are entered into the NextEra Seabrook corrective action program, the NRC treated those findings as non-cited violations, consistent with Section 2.3.2 of the NRC Enforcement Policy.

Project Priorities

1. Ensure operability determination is adequate and applicable to current plant conditions until the concern is fully understood.

2. Ensure compensatory and mitigating actions taken are adequate to ensure the ability of the affected structures to perform its intended safety function until the condition ASR on the affected structures is fully understood.

3. Verify that the methods and assumptions being used to address the condition are consistent with the current license basis.

4. The review of any changes to the licensing basis submitted by the licensee will be processed in accordance with NRR LIC-101, "License Amendment Review Procedures."

Scope of Activities

The SAITT shall develop an action plan in accordance with LIC-502, Revision 2, "Procedure for Development, Implementation, and Management if Action Plans" (ADAMS Accession No. ML091950193). The SAITT shall provide:

a. Oversight between the NRC offices participating in the review of the Seabrook ASR issue. In addition, serve as the focal point for status of the ASR issue and for coordination between the Region and the Headquarters Offices, including periodic status briefings to the Director of NRR and the Regional Administrator, Region I.

b. Coordinated resource development for the budget process.

c. Communication of licensing and technical issues to NRC management, and internal and external stakeholders, as appropriate.

SAITT Duration

The SAITT will be in effect until such time as mutually agreed upon by the Regional Administrator, Region I and the Director of NRR.

Reporting Responsibility

The SAITT will report to the Regional Administrator of Region I.

SAITT Membership

Chairperson:	Chris Miller, Director, DRS, Region I
Alternate:	James Clifford, Director, DRP, Region I
Vice Chairman:	Louise Lund, Deputy Director, DORL, NRR
Alternate:	Melanie Galloway, Deputy Director, DLR, NRR
Members:	Meena Khanna, Chief, DORL, NRR
	Rich Conte, Branch Chief, DRS, Region I
	Art Burritt, Branch Chief, DRP, Region I
	Michael Marshall, Branch Chief, DLR, NRR
	John G. Lamb, Senior Project Manager, DORL, NRR
	Martin Murphy, Branch Chief, EMCB, NRR
	Kamal Manoly, Senior Level Advisor, DE, NRR
	William Raymond, Senior Resident Inspector
Alternates:	Suresh Chaudhary, Senior Engineer, DRS, R-I
	Abdul Sheikh, Senior Engineer, DLR, NRR
	George Thomas, Senior Engineer, EMCB, NRR
	Alice Erickson, Engineer, DLR, NRR

A quorum for acceptance of decisions made will consist of the Chairman or Vice Chairman and two other members or their alternates.

Other members may include representative staff from NRO, RES, and other offices, as necessary, and other NRR and Region I support staff members who may assist the SAITT in its activities.

Estimated Number and Frequency of Group Meetings

One or more meetings per year; beginning in the summer of 2012.

3. **ASSUMPTIONS AND CONSTRAINSTS**

The objective of this charter and the implementation of the project activities assume that the budgets for each fiscal year covering the project duration will be adequate to support the actions.

The completion of the project is constrained by the ability of NextEra to provide quality documentation to support the NRC staff's review in a timely fashion.

4. **REVISIONS TO THE CHARTER**

The Chairman and Vice Chairman are jointly authorized to make changes to this charter that do not reduce its overall effectiveness in meeting the objectives delineated in the project priorities, without the prior concurrence of the approval authority.

5. **THIS CHARTER IS APPROVED FOR IMPLEMENTATION ON _____ 2012:**

William M. Dean, Regional Administrator Region I	Eric J. Leeds, Director Office of Nuclear Reactor Regulation

MANAGEMENT BRIEF
MAY 4, 2012
Seabrook Degraded Concrete due to Alkai-Silica Reaction (ASR)
Issue CAL for May 9, 2010

Time/Location: 200-300pm, Executive Conference Room, Region I

Objective (Purpose):
1. Brief Regional Management on status of actions from the April 23, 2012 management meeting.

2. Discuss expected content of letter due in May 3 or 4, 2012 [verbal commitment at the management meeting was May 6, 2012 (Sunday)].

3. Briefly discuss open technical questions related to good baseline operability determination and related monitoring program until the R&D results are in.

4. Briefly discuss clearer picture of path forward at least until September 2012 with viable options.

Success (Outcomes):
1. Understanding of the information discussed by addressing questions that come up.

2. Track additional actions or other informational needs for follow-up.

3. Discuss next steps including coordination needed with NRR and others for CAL to be issued on May 9.

Agenda (Process):
1. Understood regulatory commitments from April 23, 2012 meeting.

2. Open technical issues based on management meeting and preliminary review of documents available for review

3. Decision with actions related to CAL for May 9, 2012 (Comm Plan)

4. Path Forward (Short and Longer Term)

5. Summary/Critique

TALKING POINTS – Seabrook ASR Issue CAL for May 9, 2012

1. Understood regulatory commitments from April 23, 2012 meeting

As such, your letter of May 3/4, 2012 (Agencywide Documents Access & Management System (ADAMS) ML XXXXXX), describe actions you will take at Seabrook to ensure a bounding operability determination is completed for all ASR-effected buildings as well as interim monitoring actions to ensure the degradation is effectively managed until the result of the longer term research and development is completed between 2013 and 2014. Those regulatory commitments addressed below are expected to be completed as indicated:

1. By May X, 2012 NextEra will complete the updated operability determinations for the control building (Lic. Doc. No.....) to reflect the bounding calculations completed in an Engineering Evaluation completed in April 2012.
2. By May X, 2012 NextEra will complete the updated operability determinations for all ASR-effected buildings (Lic. Doc. Nos.....) to reflect the bounding calculations completed in an Engineering Evaluation completed in April 2012.
3. By May X, 2012, NextEra will submit to the NRC a summary of test results for the short term mortar bar testing per ASTM XXXX in order to provide a conservatively high estimate of reaction rate.
4. By June X, 2012, NextEra will provide a date when it will provide a summary of the longer term reactivity reaction rate tests, expected to be completed in 2013.
5. By May X, 2012, NextEra will provide summary of the root cause evaluation for the ASR problem.
6. By May X, 2012, NextEra will submit its aging management plan to be implemented by June 20, 2012
7. By May 25, 2012, NextEra will submit its Engineering Evaluaiton completed in April 2012 redacted for proprietary information.
8. By May X, 2012, NextEra will submit technical details for testing at the University of Texas.
9. By May X, 2012 NextEra will provide the date when the updated structures monitoring program will be available for onsite review and implementation.
10. By June X, 2012, NextEra will submit the results of its crack mapping and indexing results for twnty areas reviewed in June 2012
11. By May X, 2012, NextEra will submit a summary of anchor testing to date at the University of Texas.
12. By June X, 2012, NextEra will submit an intergrated Corrective Action Plan for this significant condition adverse to quality.

It should be note that, as NRC staff review of this information is completed, additional technical details may be needed subject to requests for additional information

SEE NEXT SECTION

2. Open technical issues based on management meeting and preliminary review of documents available for review

DO NOT PLAN TO GO THROUGH DETAILS OF ATTACHMENTS UNLESS THERE ARE SPECIFIC QUESTION FROM READING

Attachment 1 summarizes the high level technical issues associated with the application of the ACI design code to the current situation.

Acceptable areas can be documented in pending inspection for this summer.

Will need to know the unacceptable areas and have the working group engage NextEra with appropriate communications and written products.

Attachment 2 lists the information we sought at the April 23 meeting as listed in Attachment 3 and how we would get the information formally (CAL/5054f)

– for the most part we got it and then some but we need to review the details in the documents available or to be submitted – caveat provided in draft CAL

Attachment 4 is a tentative list of topics addressed at the April 23 meeting – it was not transcribed so we need to meet with technical staff on were the right answers given.

The new information in the last two weeks is that by the bounding calculation, some areas of the plant appear to cut into design margin vs. reserve capacity – staff needs to better understand this along with the details of the calculations.

Do we agree with the Engineering views on why the bounding calculation is too conservative without additional testing?

What additional testing is viable, dependable, etc. NextEra and Ferguson Labs challenged us on a few areas.

All of this should NOT hold up the issuance of the CAL for an initial footprint – revisions and other tools remain available – See attachment 3 CAL vs 5054f.

3. Decision with actions related to CAL for May 9, 2012 (Comm Plan)

For now we got what we needed

Issue initial CAL on May 9 based on NextEra letter of May 3 o 4

Exit strategy:
Adequate baseline OD updated May or June 2012 as reviewed by NRC staff
Adequate interim monitoring plan until R&D effort is complete
No open issues from Corrective Action Plan

Several technical issues need to be resolved pending a review of documents.
Longer term licensing bases can be addressed by a 5054f, if needed.

Coordination with NRR/Headquarters
Regional Counsel and OGC concurrence (Hearing File)
ASR counterpart Executive Brief Tuesday May 8, 300pm
Comm Plan Yes
Others EDO??? – Bowman brief – TA brief

4. Path Forward (Short and Longer Term)

Short Term to September 2012:

1. When CAL issued, open inspection report and continue review of available documents IAW 92702 with support from NRR [DIRS and Research??? (User needs being developed by DLR)]

2. Plan Open Public meeting for the inspection end <summer end

3. Be prepared to address safety concerns and needs for immediate information via teleconferences, revised letters, revised CAL or more significant footprints on an as needed basis.

4. Document acceptable areas in first quarterly ASR report.

5. NRR with RI concurrence issue action plan and identify working group from various NRC offices.

6. Consider additional quarter ASR reports as guidance is developed and implement from the working group (possible licensing action 50.54f letter).

7. Have working group consider resource loading post CAL/5054f letter era for a year.

8. Working Group needs to start functioning on:
    a. Documents available in Certrec (RCE and Eng. Eval.) and other summary information coming in May/June 2012
    b. CAP when in.
    c. Plan and Implement 1st Quarterly ASR inspection report – open public exit
    d. Consider Monthly status report (facts, no conclusions or findings) as a public outreach PM to Executive Sponsor with lot of help from EB1/PB3
    e. Address TIA in public domain.
    f. Continue with technical Q&As

Longer Term >September 2012 to 2013/2014:

1. Consider CAL closeout if not done by Sept. 2012 or other footprints
2. Continue monthly status report, will there be enough to report on
3. Continue quarterly inspection reports, if needed
4. Monitoring onsite activities in the interim
5. Monitoring UofT activities in the interim and longer term
6. Others

5. Summary/Critique

Revisit purpose and success

Attachment 1 – Open Technical Issues Pending Further Review of Documents

Open Technical Issues	Licensing	Inspection
Baseline Operability until R&D Effort is completed.	Support on bounding calculation	Lead Effort to support public meeting at the end of the summer, region has open URIs on final operability.
	Focus on "slight" deviation from ACI 318-1971 Slide 31 from NextEra	Eng. Eval. looks highly qualitative in addressing bound calc. design margin issues
	What type of core testing can address the problem?	Triaxial vs. split tensile
RESULT	NRR support needed on NextEra actions to address and id. licensing bases issues - if **NOT** acceptable need immediate communications	Region I needs to lead this effort with the inspection report as a vehicle to exit, have open meeting, and document acceptable areas.
Interim monitoring program until R&D Effort is completed	Factor in license renewal principles, e.g., crack mapping and indexing	Lead Effort to support public meeting at the end of the summer, region has open URIs on final operability.
	Other testing needed???\ -Short term reactive suspect -Longer term results not for a year -Stiffness damage test in literature challenged.	University of Colorado says they can do triaxial testing (5 cores available)
RESULT	NRR support needed on NextEra actions to address and id. licensing bases issues - if **NOT** acceptable need immediate communications	Region I needs to lead this effort with the inspection report as a vehicle to exit, have open meeting, and document acceptable areas.

Open Technical Issues	Licensing	Inspection
General applicability of ACI 318-1971 in light of technical challenge that ACI relationships may not be valid (is this a potential backfit???)	Design bases information, a new design bases appears to be inevitable even though a licensing action is not before us. Should 50.59 process be used for Texas R&D – it appears to be a alternate way to comply or a compensatory measure in meeting licensing basis Do we need to consult with ACI committee	Enforcement appears to be weak in light of construction applicability even though the region opened an URI on it in 2011-010. Enforcement may be weak in order to get licensing action submitted for anything done offsite
RESULT	NRR lead for now, if **NOT** acceptable need immediate communications	Need decision soon, can't wait for end of summer
General applicability of section 4 and 20 of ACI 318-1971 related to compressive strength testing and methodology to use.	Design bases information, a new design bases appears to be inevitable even though a licensing action is not before us. Support determination that process to be used in Texas is adequate to meet code	Not clear that core data is outside of criteria in section 4, ave < 85% of design and any one 500 psi < 85% of design Need to do additional cores on compressive strength – this isn't the problem, its shear and tensile strength. Can we enforce 50.59 deviation in methodology – in-situ load test the buildings
RESULT	NRR lead for now, if **NOT** acceptable need immediate communications	Need decision soon, can't wait for end of summer
Visual Criteria for evidence of ASR in the expanded extent of condition review	Review criteria as presented in management meeting Previous discussions indicated that is can only be done by petrography	Issue can be raised in PIR sample on RCE Apply to Containment crazed cracking or does a shallow core need to be taken
RESULT	NRR lead for now, if **NOT** acceptable need immediate communications	Acceptability can be documented in summer inspection

Open Technical Issues	**Licensing**	**Inspection**
Answers to the TIA five questions: 1) comprehensive list of issues for final OD 2) Id original design assumptions in UFSAR DB affected by ASR - ACI code relationship 3) Appropriate ACI standard for core sampling for CB (other areas implied to ensure representativeness [(Uof T) work not recognized at the time.] 4) Adequacy of lab testing conducted to date and parameters obtained 5) Current structures monitoring program adequate to ensure discover and predict additional damage < impacting negatively the DB of the structure.	Is a branch technical position needed on how to evaluate ASR problem.	Needs to be addressed in public domain but things have changed especially for Q3 and Q4.

Attachment 2		
Topic/Area	**Pro for CAL (Con for 5054f unless specifically noted)**	**Pro for 5054f (Con for CAL unless specifically noted)**
SPECIFIC INFORMATION NEEDS:		
1. Initial assessment of in-scope buildings – what buildings are affected basis for confirming presence of ASR.	Confirm commitment, need to know when documents submitted	Ask for the information needed Need to decide acceptable methods used without petrography.
2. Updating OD for all buildings – Bounding Calc. or Method, Analysis, or Test. Key information needed: key assumptions, bases for input; and calculation methods used for material properties	Confirm commitments, need to know when documents submitted.	What condidence do we have in the technical rigor used by NextEra and its contractor on 25% reduction for shear and 40% reduction for modulus of elasticity.
3. Continued use of empirical relationships of DBC, ACI 318 – what is basis and what is explanation of appropriate use for the degraded conditions in the buildings.	Confirm commitments, need to know when documents submitted.	What was done in finite element analysis for RHR and CEB? Bounding calc. needs to be reviewed for adequacy but even when the Eng. Eval. Is submitted, reference calcs. Need to be reviewed on site or by certrec Use of Certrec may be needed to get a short term decision shortly after May 25th.
4. Ongoing or planned method, analysis, or tests to be used to monitor or manage ASR affected structures. Knowledge of ASR reaction rate, possible end point, and how it effects operability.	Confirm commitments, need to know when documents submitted. CAP and AMP to be submitted on May 25.	Is it acceptable?
5. Corrective Action Plan needs to address all of the above	Confirm commitments, need to know when documents submitted. CAP and AMP to be submitted on May 25.	Is it acceptable?

6. When will they provide technical basis for larger scale testing plan at R&D facility.	Confirm commitments, need to know when documents submitted. CAP and AMP to be submitted on May 25	Is it acceptable?
7. When do they plan to complete the identification of all of the long term aging effects of ASR on the affected structures.	Confirm commitments, need to know when documents submitted. CAP to be submitted on May 25	Is it acceptable?
8 When do you plan to submit an aging management program for the ASR affected structures.	Confirm commitments, need to know when documents submitted. AMP to be submitted on May 25	Is it acceptable?
More immediate commitments needed for items 1, 2, 3 and to some extent 4 in order to establish baseline ODs and interim monitoring until the R&D effort is complete.	**Region I issue CAL shortly after May 9 based n May 3-4 letter with caveat on RAI may be needed when information is submitted.** **Revised CAL or 5054f inevitable**	**NRR needs to focus on potential change to licensing basis and what it needs to support that review** **Monitoring the R&D effort in Austin Texas (QA/QC)**

Attachment 3

Questions for Seabrook ASR Public Meeting on April 23, 2012

1. What buildings are affected by alkali silica reaction (ASR)? How do you plan to confirm ASR and what is your supporting basis?

2. When do you plan to update the operability determinations for all buildings affected by ASR and what key information do you plan to incorporate into them including key assumptions, bases for inputs, including material properties, and calculation methods used?

3. If you continue to use the empirical relationships in the American Concrete Institute (ACI) design basis code for operability determinations, what is the basis for use of those relationships, and what is the explanation regarding why these are appropriate for the degraded conditions in the building?

4. What are your ongoing or planned methods, analysis or testing that will be used to monitor/manage ASR affected structures? What is your knowledge of the ASR reaction rate, possible end point, and how it affects operability?

5. When will you submit to the NRC staff your Corrective Action Plan to address this issue?

6. When will you provide the technical details for the larger-scale testing planned at the contracted research and development facility?

7. When do you plan to complete the identification of all of the long-term aging effects of ASR on the affected structures?

8. When do you plan to submit an aging management program for the ASR-affected structures?

Attachment 4

Q&As from the April 23, Meeting

1. What are you, NextEra doing with the 5 of 20 cores in the Engineering Building that were not tested for compressive strength?

   ANS: Nothing right now, but they may be tested for some future use.

2. (Slide 11) ASR impacts material properties [compressive strength, modulus of elasticity, flexural stiffness, shear strength, tensile strength (does this include bond strength?)]. Structural performance of concrete elements depends if concrete is confined vs. unconfined. Design basis is unconfined core testing for compressive strength, how do we reconcile this with the licensee and U of T position that confined core testing is invalid vs. inaccurate by 15%?

   ANS: Triaxial test has not been considered no reason given as to why ASTM rescinded procedure – [Uni. Of Colorado says they can do it?]

3. Licensee slide 13, data on compressive strength, the 22% reduction could be as high as 35% if the concrete pour value is considered at 4K vs. 3K. Slide 13 - Test results confirm no reduction in compressive strength is misleading.

   ANS: They gave a explanation of one company's data vs another and that is why they used a third lab and the compressive strength number came out better. Core aspect ratio was the problem with one of the vendors.

4. Basis for Crazed Cracking not being ASR?

   ANS: They gave their visual criteria in their slides and it doesn't meet the criteria. [No suggestions of shallow core examination were given by anyone.]

5. Slide 16 14 + areas confirmed by the following criteria: 1) pattern cracking, 2) secondary deposits, 3) staining and discoloration, and 4) deposits of alkali silica gel.

   ANS: No need to do petrography. [Do we believe it.]

6. There was also a discussion on passive and active cracks that are well within the action criteria of ACI 349.3R – structural evaluation still done. Not sure what the question was unless it was related to No. 4 above on basis for adequacy of visuals.

   ANS: ???.

7. Crack indications – best measure ????

   ANS: ???.

8. Core vs. cylinder testing – ACI code 15% delta might be an estimated of confined vs. unconfined values for compressive strength (section 4 of 318-1971)

ANS: could be but not sure???.

9. (Slide 22) CEB Finite Element Analysis, parameters used as input?

   ANS: reduced modulus only.

10. (Slide 23) Observation on the inside wall is where ASR manifests itself. Where there any opportunities to examine the outside underground portions of the walls?

    ANS: No.

11. (Slide 25) Testing unconfined cores for splitting tensile strength and stiffness damage is not representative of the structural context

    ANS: Dr. Bayrak second set of slides No. 24-26 gave a plausible answer for cores aged and already cracked vs. new cylinders during new construction testing.

12. (Slide 28 & 31) Once testing is successfully complete, OD will be closed documenting compliance with ACI 318-1971. See 15 evaluations in 5 areas slightly below design basis. [Questions not asked: Eng. Eval has margin numbers of 1% to 22%, which is the least which is the most; How can compliance with ACI be demonstrated when it was designed without ASR in its calculation methods might be invalid]

    ANS: The eng. eval. appears to give high level qualitative assessment, although slide 30 says additional analyses were conducted considering actual demand on structural capacity

13. (Slide 33 and 34), lots of questions on root cause evaluation especially second cause on not validating Failure Modes in the future once an assessment is completed?

    ANS: relevance and importance? were all questions sufficiently answered ???. [un-asked question: why wasn't the high volume low threshold system used at least form the start of the ROP in 2000 to tackle the issue of GW infiltration]

14. After morning lunch - Letter of May 6 to provide dates of when things will be done or what will be submitted.????

    ANS: Need to confirm???.

15. Design Margin and defense in depth – MPR Eng. Eval report?

    ANS: ???.

16. Lehigh vs Portland cement, how will you assure beam construction replicates Seabrook conditions?

    ANS: Review of mil specs.

17. In-situ temperature and monitoring, why not being done?

ANS: Expansion leveling off, higher temperature quickens growth, only affects initial and peak reaction rate – [this could be an issue for monitoring program that gets us form good baseline OD to R&D test results]

18. Final OD May 2013 based on UofT R&D on beam replicating Seabrook current conditions; Final R&D report after accelerated ASR beam testing in 2014.

    ANS: OK [what licensing and inspection review is need at UofT – no inspection program covers including 2516 on License Renewal].

19. ACI 318, core requirements; passing judgment, using core data is an illusion.

    ANS: ???.

20. Cycle tests or specification (hysteresis, at what point ASR indication affects structure – rebar fracture?

    ANS: ???.

Supporting Quantitative Data for **"There are no immediate Safety Concerns because there are significant conservatisms and margins available."**

The following are based on the worst ASR-affected structure, **the *B Electrical Tunnel under the Control Building*.**

A. MARGINS (for ASR-affected areas accounting for reduced modulus, compressive strength)

- **Flexure** (i.e bending)

  M_{cap} = 141 k-ft; M_{cap_red} = 138 k-ft; M_{design} = 96.6 k-ft (Calc C-S-1-10150 and Calc CD-20)

  M_{cap_red} / M_{design} = 1.43

- **Shear** (Out-of-plane or transverse is critical)

  V_c = 28.63 k based on fc = 5458 psi (Calc CD-20)

  V_{c_red} = 26.85 k based on fc = 4790 psi (Calc C-S-1-10159)

  V_{design} = 25.185 k Calc CD-20 and C-S-1-10159)

  V_{c_red} / V_{design} = 1.07

- **Reduced Natural frequency = 28.9 Hz** (AR 581434, Rev 001), Still in rigid range

- **Anchorage** (AR 581434, Rev 001)

  - **Cast-in place anchors** (designed for steel yield before concrete fails)

    Safety margin for concrete capacity in ASR affected areas = 1.8 (min)

  - **Drilled-in Anchors**

    Safety factor = 4, in original design

B. CONSERVATISMS (for operability considerations – not design basis)

Note that Operability Determination is "Operable but degraded or non-conforming (below full qualification)."

Governing load combinations are as below (page 7 and App A of Calc CD-20):

Normal (Service) Load Condition:

(a) 1.4 Dead + 1.7 Live + 1.4 Hydro + 1.0 Earth + 1.9 OBE

Unusual (Extreme) Load Condition:

(b) 1.0 Dead + 1.0 Live + 1.0 Hydro + 1.0 Earth + 1.0 SSE

Based on UFSAR 3.8.4.5, the acceptance criteria for both the normal and unusual load conditions are the ultimate strength method in ACI 318-71, where the structures are designed to maintain elastic behavior (below yield strength capacity) under all normal as well as unusual load conditions. It is noted that both the load conditions (a) and (b) have the same individual loads, but with different load factors. It is obvious that the normal load condition (a) with higher load factors governs over the unusual load condition (b) (also see page 7 of calc CD-20). This is because higher load factors are used for normal (service loads) to analytically increase the loads for comparison to the ultimate strength capacity and thereby also ensures higher safety factors and lower stresses under normal service conditions.

Essentially, for the above reason, the "normal (service)" load conditions govern the design over "unusual" load conditions for below-grade Cat 1 structures.

In the above load conditions, Earth pressure is zero since backfill material for Cat 1 structures is backfill concrete (Ref page A-2 of calc CD-20 and UFSAR 2.5.4.5). Further, for out-of-plane considerations, only lateral loads govern. Therefore, for the critical lateral effects, the above load conditions reduce to:

(c) 1.4 Hydro + 1.9 OBE, for normal conditions

(d) 1.0 Hydro + 1.0 SSE, for unusual conditions (with SSE = 2 OBE)

Appendix A of calc CD-20 indicates that for the governing load condition (c), the seismic load is only 4 percent of the hyrostatic pressure load. Therefore, the hydrostatic load is the significant load governing the design with a load factor multiplier of 1.4 (per code) in load condition (c) compared to 1.0 in load condition (d), both having the same loads and same ultimate strength acceptance criteria.

Thus, for operability considerations, there is an additional analytical conservatism of approximately 1.4 (or 40 percent) for the governing load condition in the margins for flexure and shear (critical with lowest margin of 1.07) indicated in the previous section. This would **increase the margin for transverse shear to 1.07 x 1.4 = 1.5, and for flexure to 1.43 x 1.4 = 2.0**

This 40% analytical conservatism can be credited in an operability evaluation to offset some of the uncertainty in shear capacity caused by ASR and its impacts. Literature indicates there could be up to a 25 percent reduction in shear capacity due to ASR.

<u>Other conservatisms used in the calculations are:</u>

- Values used for OBE is 0.15g and SSE is 0.28g in comparison to 0.125g and 0.25 g in UFSAR.
- Concrete cover was considered as 5" instead of the actual 3" which reduced the value of effective depth d for a 24" thick wall from 21" to 19".

- Hydrostatic pressure was calculated with a conservative design basis flood elevation corresponding to grade level (EL 20 ft). Actual could be about 5 ft lower.

C. **Test Data for "B" Electrical Tunnel for compressive strength (fc) and elastic modulus (Ec)**

For the 15 cores tested in Nov 2011, **average fc = 5090 psi**

For the 12 cores tested earlier in 2011, **average fc = 4790 psi**

For all the 27 of the above cores, **average fc = 4957 psi, say 5000 psi.**

These compare to the average 28-day cylinder test strength fc = 6163 psi (App A to Calc CD-20), which is approximately a 20 percent reduction in average compressive strength. (

Note that fc = 3000 psi was used in original design except that fc = 5458 psi was used in original design for transverse shear only (Calc CD-20). The concrete mix that was actually placed was 4000 psi.

Based on 4 cores tested, average **Ec = 2075 ksi.**

This compares to design values (= 57 sqrt(fc)) of 3120 ksi (based on fc = 3000 psi); 3605 ksi (based on fc = 4000 psi); and 4030 ksi (based on fc = 5000 psi). The corresponding reduction in average Ec are 33 percent, 42 percent and 48 percent, respectively.

Lamb, John

From: Lamb, John MNCR
Sent: Tuesday, March 06, 2012 12:30 PM
To: Lamb, John; Khanna, Meena; Burritt, Arthur; Marshall, Michael; Murphy, Martin; Raymond, William; Conte, Richard; Thomas, George; Sheikh, Abdul; Chaudhary, Suresh; Cunanan, Arthur; Erickson, Alice; Galloway, Melanie; Lund, Louise; Miller, Chris; Cheok, Michael
Subject: For Your Review - Revision 17 - Dry Run of Slides for Chairman Brief regarding Seabrook ASR
Attachments: Seabrook ASR - Chairman Brief Slides_ March 2012 - Rev 17.pptx

Importance: High

ADAMSAccessionNumber: ML120680272

Ladies & Gentlemen:

Attached is Revision 17 of the DRAFT slides for the Chairman brief. Revision 17 reflects all inputs to date.

The dry run is scheduled for Tuesday, March 6, 2012, at 1:00 pm (Eastern time).

Thanks for the support.
John

B8

Seabrook Concrete Degradation by Alkali Silica Reaction

NRC Staff Briefing to

Chairman Jaczko

March 8, 2012

Agenda

- Current NRC Assessment of ASR Affected Structures
- NRC Staff Actions
- Path Forward

Current NRC Assessment of ASR Affected Structures

- No immediate safety concern.
- The ASR structures are operable but degraded (below full qualification), and subject to corrective action because:
  - Conservative safety load factors in controlling load conditions and engineering conservatisms in design provide reasonable expectation that affected structures can perform their safety function, despite the CLB design margin being reduced by the reduction of mechanical properties,
  - Field walk-downs confirm no visible indication of significant deformation, distortion, or displacement of structures, or rebar corrosion,
  - ASR identified at localized areas in the concrete walls,
  - Progression of ASR degradation occurs slowly based on existing operating experience and published literature, and the licensee continues to monitor, and
  - Laboratory tests performed so far indicate reduction in mechanical properties consistent with published literature.

NRC Staff Actions

- Summary of RI ASR Inspection Report
  - Issues need to be factored into a comprehensive corrective action plan for a significant condition adverse to quality.
  - To be issued by mid March 2012, calling for a management meeting, because
    - NextEra taking a new direction away from core sampling.
    - New direction is extensive research and development at the University of Texas.
    - New direction is based on, in part, the need to address issues related to validity of the design bases code relationships for ASR-affected concrete.
    - Other key principles will need to be addressed for either research effort.

NRC Staff Actions

- Other Performance Issues Addressed in the RI ASR Inspection Report
  - One unresolved item (URI) closed - resulted in a finding of very low safety significance.
    - Engineering change from May 2011 accepted the degraded concrete property conditions without a safety evaluation as required by 10 CFR 50.59.
    - Screening process was only used.
  - Another URI updated - related to the open prompt operability determinations
    - Work done by the staff related to NextEra control of contractors and laboratory testing.
  - For the Review of the Open URI - a finding of very low safety significant was identified
    - NextEra did not follow its self imposed standard for operability determination in that it did not fully evaluate available information for the control building and other buildings considered in an extent of condition review.

NRC Staff Actions

- License Renewal - LRA review schedule has been impacted due to the additional effort to study and analyze the effect of ASR. The staff cannot make a positive reasonable assurance finding until the applicant has:
  - Demonstrated that the effects of aging will be adequately managed so that the intended functions of ASR affected concrete structures will be maintained (10 CFR 54.21 (a)(1)(ii)(3)),
  - Provided an acceptable aging management program that includes consideration of ASR (10 CFR 54.21 (d)),
  - To accomplish the above, establish the effect of ASR on concrete mechanical properties: compressive, bond, shear strength, and modulus of elasticity.

Path Forward

- Degradation from ASR in Seabrook's concrete structures has no immediate safety concern; detailed testing and evaluations to comprehensively address the issue in the short-term and long-term, including updated operability determinations are ongoing.
- NRC staff continues to inspect and assess licensee activities on the issue.
- A public meeting between the NRC and NextEra management at NRC Headquarters will take place in April 2012.
- ASR issue has impacted Seabrook Station license renewal review.

Lamb, John

From: Lamb, John MVR
Sent: Wednesday, March 07, 2012 12:57 PM
To: Khanna, Meena; Burritt, Arthur; Marshall, Michael; Murphy, Martin; Raymond, William; Conte, Richard; Thomas, George; Sheikh, Abdul; Chaudhary, Suresh; Cunanan, Arthur; Erickson, Alice; Galloway, Melanie; Lund, Louise; Miller, Chris; Cheok, Michael
Subject: For Your Use - Revision 22 - FINAL Slides for Chairman Brief regarding Seabrook ASR - March 8 at 1:00 pm
Attachments: Seabrook ASR - Chairman Brief Slides_ March 2012 - Rev 22.pptx

Importance: High

ADAMSAccessionNumber: ML120690113

Ladies & Gentlemen:

Attached, for your use, is Revision 22 of the DRAFT slides for the Chairman brief. Revision 22 reflects all inputs to date. The recent changes are from Rich Conte revising Slide 4 and Slide 7 and Abdul Sheikh revising Slide 6 and Slide 7.

The slides have been frozen. Revision 22 is the FINAL version of the slides for the Chairman brief. I will make copies of the slides for the attendees in the Commissioners' Conference Room.

The Chairman brief is scheduled for **Thursday, March 8, 2012, at 1:00 pm** (Eastern time).

Thanks for the support.
John

B9

Seabrook Concrete Degradation by Alkali Silica Reaction

NRC Staff Briefing to

Chairman Jaczko

March 8, 2012

Agenda

- Current NRC Assessment of ASR Affected Structures
- NRC Staff Actions
- Path Forward

Current NRC Assessment of ASR Affected Structures

- No immediate safety concern.
- The ASR structures are operable but degraded (below full qualification), and subject to corrective action because:
  - Conservative safety load factors in controlling load conditions and engineering conservatisms in design provide reasonable expectation that affected structures can perform their safety function, despite the CLB design margin being reduced by the change of mechanical properties,
  - Field walk-downs confirm no visible indication of significant deformation, distortion, or displacement of structures, or rebar corrosion,
  - ASR identified at localized areas in the concrete walls,
  - Progression of ASR degradation occurs slowly based on existing operating experience and published literature, and the licensee continues to monitor, and
  - Laboratory tests performed so far indicate reduction in mechanical properties consistent with published literature.

NRC Staff Actions

- Summary of RI ASR Inspection Report
  - Technical and timeliness issues need to be factored into a comprehensive corrective action plan for a significant condition adverse to quality.
  - Report is expected to be issued mid March 2012, calling for a management meeting, because
    - NextEra moving away from core sampling by testing and evaluating larger scale specimens at the University of Texas.
    - This action is based on, in part, the need to address issues related to validity of the design bases code relationships for ASR-affected concrete.
    - Other technical issues will need to be addressed for the licensee's final approach or strategy.

NRC Staff Actions

- Other Performance Issues Addressed in the RI ASR Inspection Report
  - One unresolved item (URI) closed - resulted in a finding of very low safety significance
    - Engineering change from May 2011 accepted the degraded concrete property conditions without a safety evaluation as required by 10 CFR 50.59.
    - Screening process was only used.
  - Another URI updated - related to the open prompt operability determinations
    - Work done by the staff related to NextEra control of contractors and laboratory testing.
    - Technical issues that need to be addressed when finalizing the operability determinations.
  - For the Review of the URI - resulted in a finding of very low safety significance
    - NextEra did not follow its own standard for operability determination in that it did not fully evaluate available information for the control building and other buildings considered in an extent of condition review.

NRC Staff Actions

- LRA review schedule has been impacted due to the additional effort by the applicant to study and analyze the effect of ASR. The staff cannot make a positive reasonable assurance finding until the applicant has:
  - Demonstrated that the effects of aging will be adequately managed so that the intended functions of ASR affected concrete structures will be maintained (10 CFR 54.21 (a)(1)(ii)(3)),
  - Provided an acceptable aging management program that includes consideration of ASR (10 CFR 54.21 (d)),
  - To accomplish the above, understand and determine the effect of ASR on concrete mechanical properties: compressive, bond, shear strength, and modulus of elasticity over the long term.

Path Forward

- The NRC staff has no immediate safety concern regarding the reduction of mechanical properties from ASR in Seabrook's concrete structures; detailed testing and evaluations to comprehensively address the issue in the short-term and long-term, including updated operability determinations are ongoing.
- NRC staff continues to inspect and assess licensee activities on the issue.
- A public meeting between the NRC and NextEra management at NRC Headquarters will take place in April 2012, to address Part 50 and Part 54 aspects.
- Part 50 Aspects, that NextEra needs to address:
  - If they meet the current licensing and design basis for the application fo the design bases code;
  - Will the comprehensive corrective action plan effectively address the problem along with other technical issues associated the problem.
  - Timeline for key licensing bases actions.
- Part 54 Aspects, NextEra needs to:
  - Supplement the application as described on the previous slide
  - Implement the action plan, and provide the details to the NRC for review.

PRELUDE TO CAL – BC MEETING OF MAY 1, 2012

From: Marshall, Michael
Sent: Monday, April 30, 2012 10:13 AM
To: Conte, Richard; Khanna, Meena; Murphy, Martin; Burritt, Arthur
Cc: Raymond, William; Lamb, John
Subject: RE: Seabrook ASR - Path Forward/Examples of Action Plans

Hello Rich, Meena, Marty, and Art,

Considering that I am at Callaway this week and may not be able to accommodate a conference among us this week to plan our path forward, I just wanted to share my thoughts on how we should organize ourselves and proceed. Once we have a shared understanding of our objectives, the path forward and division of labor should be much clearer to all.

First, we need to establish high level objectives/outcomes – vs individual actions or products. I think the following five objectives cover our joint interests:

1a) Ensure operability determination is adequate and applicable to current and future plant conditions until the degradation is fully addressed.

1b) Ensure compensatory and mitigation actions taken or planned are adequate to ensure ability to perform intended function until degradation is fully addressed.

What are we really talking about on compensatory and mitigation actions (interim monitoring actions, e.g. there may need to be some gw level monitoring actions).

We agree EB1 as lead with support with DE/DLR

2a) Verify that the methods and assumptions being used to address the degradation are consistent with the current license basis.

2b) If the methods and assumptions are not in conformance with current licensing basis, review any changes submitted by the licensee.

This is the licensing issue DE with support from DLR with support from Region I

3) Ensure any aging management actions proposed by the applicant as part of the license renewal application are adequate to ensure ability to perform intended function during the period of extended operations.

DLR lead with support from DE and Region I

Second, we need to agree on the "nature" and priority of the issue. Although we have taken a position as an agency that there is no immediate safety concern, it appears that we want to act in a contrary manner. Based on the feedback from our technical staff, it does not appear that any of the structures will be or near the point that they cannot perform their function. Also, according to our staff, the degradation is a slow process that will reach an end point at some

indeterminate time. Therefore the nature of this issue at this time is one of licensing and compliance more so than safety.

- I know that Marty and I believe this to be more an issue of compliance that can be handled over time, than safety that needs immediate resolution. Therefore it does not warrant the priority of an issue with immediate safety concern. By the way, I do understand the public visibility of the issue, but the fact it is highly public should not overly skew the priority given the issue. Do the rest of you agree?

We don't have a good handle on OD especially with bounding calculations and insitu conditions – we may still question. We can't make the case they are inoperable.

Third, we need a branch chief (or senior staff) to assume the leadership role (including developing a plan to take us from this point forward; identifying regulatory products) to guide the completion of each objective. Based on our organizational responsibilities I would suggest that Rich or Art take 1, Marty or I take 2, and I take 3.

DORL action plan – Meena/Art – new TAC for licensing actions per action plan, TAC on TIA remains open until we close it out, Inspection action per 92702 CAL and inspection report,

Fourth, one of us needs to coordinate the overall effort. Based on our current roles, this would either be Art or Meena. Coordination would include:

- Coordination of the pooling of technical resources across organizational lines within agreed upon limits of staff availability. This coordination would involve establishing priority for resources among the various actions to meet the above five objectives.

- Coordination of the individual plans to achieve the five objections listed above. This coordination would involve establishing priorities among the various actions to meet the above five objectives and integrating the individual plans documenting our path forward.

- Bringing us together to resolve any conflicts among the individual plans.

- Coordination of external communication.

What about Research – user need from DLR, will it address ACI applicability and operability per Part 50

DIRS said they can get contractor inspection resource but guidance will need to be developed

If we do not agree with the above, we need to agree on some plan so this effort does not continue to be handled in a ad hoc day-to-day manner. It is a very inefficient way to manage this issue and our individual resources. One observation that I have shared with my management is that we are not working this issue in a very smart manner.

Michael

---

k. Commission (TA) Briefings

R. Conte Response:

Sounds like a good agenda, when to meet. I am getting tremendous pressure to issue a CAL next week on Wednesday before DRS turns into a pumpkin for Thursday and Friday move to the new building.

I would add to the list below that for sure the CLB is changing what should NRR do now to plan for success. Not sure they can demonstrate compliance with ACI codes in light of potential backfit issue, the ACI relationships are no longer valid. Also not sure they are compliant with methodology to go from compressive strength numbers not meeting code criteria, addition compressive strength testing, which seems useless at this time, and how do we reconcile that we sent them to the Freguson lab and now we are challenging their methodology.

Outcomes check from RA (CAL vs. 5054f brief):

1. Regulatory tools in place: 1) URIs not sufficient; 2) know the intent as to where licensee and NRC are headed; 3) hold their feet to fire with the appropriate tool.
2. Agency burden equally distributed and get maximum fire power.
3. **Id path forward potential objectives**:
    a. good ODs as baseline, expanded extent of review (consider causes and known condition in concrete);
    b. monitoring and managing to ensure building conditions are still bounding by analysis;
    c. integrate DLR principles or needs for longer term monitoring;
    d. when to be mitigated or when's the fix?

Need an objective for the action plan and working group to be the lead for internal and external communications

Jim Clifford was right that the caucus: I heard a lot of Q&As, were the right answers given. Perhaps they should be listed and we go point by point. – SEE NEXT PAGES.

We did not have time to discuss next pages on May 1. We need to the technical staff to review their notes to see what was addressed adequately or not.

Q&As from the April 23, Meeting

1. What are you, NextEra doing with the 5 of 20 cores in the Engineering Building that were not tested for compressive strength?

   ANS: Nothing right but they may be tested for some future use.

2. (Slide 11) ASR impacts material properties [compressive strength, modulus of elasticity, flexural stiffness, shear strength, tensile strength (does this include bond strength?)]. Structural performance of concrete elements depends if concrete is confined vs. unconfined. Design basis is unconfined core testing for compressive strength, how do we reconcile this with the licensee and U of T position that confined core testing is invalid vs. inaccurate by 15%?

   ANS: Triaxial test has been poo-hoo'd without much basis or reason as to why ASTM rescinded procedure – Uni. Of Colorado says they can do it?

3. Licensee slide 13, data on compressive strength, the 22% reduction could be as high as 35% if the pour value is considered at 4K s. 3K. Slide 13 - Test results confirm no reduction in compressive strength is misleading.

   ANS: They gave a explanation of one company's data vs another and that is why they used a third lab and the compressive strength number came out better. Aspect ratio was the problem with one of the vendors.

4. Basis for Crazed Cracking not being ASR?

   ANS: They gave their visual criteria in their slides and it doesn't meet the criteria. No suggestions of shallow core examination were given by anyone.

5. Slide 16 14 + areas confirmed by the following criteria: 1) pattern cracking, 2) secondary deposits, 3) staining and discoloration, and 4) deposits of alkali silica gel.

   ANS: No need to do petrography. Do we believe it.

6. There was also a discussion on passive and active cracks that are well within the action criteria of ACI 349.3R – structural evaluation still done. Not sure what the question was unless it was related to No. 4 above on basis for adequacy of visuals – NextEra criteria with 14 additional areas identified appears conservative.

   ANS: ???.

7. Crack indications – best measure ????

   ANS: ???.

8. Core vs. cylinder testing – ACI code 15% delta might be an estimated of confined vs. unconfined values for compressive strength (section 4 of 318-1971)

   ANS: ???.

9. (Slide 22) CEB Finite Element Analysis, parameters used as input?

   ANS: reduced modulus only. Is this ok, will need to reviewed?

10. (Slide 23) Observation on the inside wall is where ASR manifests itself. Where there any opportunities to examine the outside underground portions of the walls?

    ANS: No. Do we believe the manifestation on inside wall, due to hydrology pressure?

11. (Slide 25) Testing unconfined cores for splitting tensile strength and stiffness damage is not representative of the structural context

    ANS: Dr. Bayrak second set of slides No. 24-26 appear to be plausible.

12. (Slide 28 & 31) Once testing is successfully complete, OD will be closed documenting compliance with ACI 318-1971. See 15 evaluations in 5 areas slightly below design basis. [Questions not asked: Eng. Eval has margin numbers of 1% to 22%, which is the least which is the most; How can compliance with ACI be domenstrated when it was designed without ASR in its calculation methods might be invalid]

    ANS: This was the surprise of the day. The eng. eval. Appears to be hand-waving, although slide 30 says additional analyses were conducted considering actual demand on structural capacity

13. (Slide 33 and 34), lots of questions on root cause evaluation especially second cause on not validating Failure Modes in the future once an assessment is completed?

    ANS: relevance and importance? were all questions sufficiently answered ???. [un-asked question: why wasn't the high volume low threshold system used at least form the start of the ROP in 2000 to tackle the issue of GW infiltration]

14. After morning lunch - Letter of May 6 to provide dates of when things will be done or what will be submitted.????

    ANS: Need to confirm???.

15. Design Margin and defense in depth – MPR Eng. Eval report?

    ANS: ???.

16. Lehigh vs Portland cement, how will you assure beam construction replicates Seabrook conditions?

    ANS: Review of milspecs.

17. In-situ temperature and monitoring, why not being done?

    ANS: Expansion leveling off, higher temperature quickens growth, only affects initial and peak reaction rate – [this could be an issue for monitoring program that gets us form good baseline OD to R&D test results]

18. Final OD May 2013 based on UofT R&D on beam replicating Seabrook current conditions; Final R&D report after accelerated ASR beam testing in 2014.

    ANS: OK [what licensing and inspection review is need at UofT – no inspection program covers including 2516 on License Renewal].

19. ACI 318, core requirements; passing judgment, using core data is an illusion.

    ANS: ???.

20. Cycle tests or specification (hysteresis, at what point ASR indication affects structure – rebar fracture?

    ANS: ???.

May 4, 2012

Results of Debrief with RA, Bill Dean:

Attending: Rich Conte, Marjorie McLaughlin, David Lew, Chris Miller, Darrell Roberts
By Phone: Meena Khanna, John Lamb, Art Burritt

1. Revise the prompt operability determination (POD) associated with AR581434, 'Reduced Concrete Properties Below Grade in "B" Electrical Tunnel Exterior Wall,' by June 30, 2012.

Why the June 30 date when you said May 25 at the management meeting and is June 30 consistent with your OD administrative procedure when new information come to light such as the bounding calculations from the Eng. Eval. available on or about April 6th.

Can we get in writing a verbal notification within 30 days of results being available for review and a verbal notification within 15 days for any significant conditions adverse to quality for this item or any item in which they commit to complete without submitting..

2. Revise the POD associated with AR1664399, 'Reduced Concrete Modulus of Elasticity Below Grade in Containment Enclosure Building, RHR Equipment Vaults, EFW Pump House, and Diesel Generator Fuel Oil Storage Rooms,' by June 30,2012. **[Need OD on expanded scope of buildings]**

Why the June 30 date when you said May 25 at the management meeting and is June 30 consistent with your OD administrative procedure when new information come to light such as the bounding calculations from the Eng. Eval. available on or about April 6th.

If you confirmed ASR in the expand scope of buildings as a part of the initial assessment, why aren't you doing ODs for those buildings such as Alt. Cooling Tower and SW pump house.

[We thought ASR was not confirmed in the RCA tunnel why does the Eng. Eval. address vulnerabilities in RCA Tunnel – an aside question, is there an accuracy issue here.]

Can we get in writing a verbal notification within 30 days of results being available for review and a verbal notification within 15 days for any significant conditions adverse to quality for this item or any item in which they commit to complete without submitting..

3. Complete short term aggregate expansion testing (ASTM C 1260 Mortar Bar Expansion Test) by June 30 2012. Results will be available to the NRC approximately 30 days after testing is complete.

4. Complete long term aggregate expansion testing (ASTM C 1293 Concrete Prism Test) by June 30, 2013. Results will be available to the NRC approximately 30 days after testing is complete.

Reconfirm with NRC tech staff the use of these ASTMs for 3 and 4 are ok

5. Submit the root cause and corrective actions for the occurrence of ASR at Seabrook Station by May 25, 2012.

What is the difference between 5 and 8 OR why doesn't 5 give all the CA needed for the operability determination and the problem

6. Submit the License Renewal Aging Management Program for ASR-affected structures by May 25, 2012 (reliance on this commitment for this CAL is limited to those actions needed to support 10 CFR 50 applicability pending further review by NRC staff).

Comment to licensee, this will be eliminated from the list – but are the principles used here and needed now 18 years earlier than expected included in item 10 below for the structures monitoring program.

7. Submit the evaluation of the impact of ASR on concrete structures and attachments at Seabrook Station by May 25, 2012.

Can licensee be more specific in terms of document name and purpose etc. More verbage

8. Submit an ASR integrated corrective action plan by June 8, 2012.

Can licensee be more specific in terms of document name and purpose etc. More verbage in light of comment from item 5 above.

9. Submit the technical details of the testing planned at the contracted research and development facility by June 30, 2012.

Will this include key milestones and dates when they occur

Will App. B be factored into the testing.

How does this testing offsite meet ACI 318-1971 (section 4 to 20 and analysis, in distinction to load tests or by a combination of these methods, when strength of existing structure is in question. (NRC approval or not)

10. Update the Maintenance Rule Structures Monitoring Program to include monitoring requirements for selected locations in areas that exhibit ASR by July 15, 2012.

See item 6 above.

11. Perform six-month interval crack measurements and crack indexing at 20 locations in areas that exhibit the highest crack indices by July 15, 2012

Is there a periodicity to this until a certain date.

Can staff rely on technical basis internal to the site.

Can we get in writing a verbal notification within 30 days of results being available for review and a verbal notification within 15 days for any significant conditions adverse to quality for this item or any item in which they commit to complete with submitting..

12. Complete anchor test program by December 31, 2012.

Can we get in writing a verbal notification within 30 days of results being available for review and a verbal notification within 15 days for any significant conditions adverse to quality for this item or any item in which they commit to complete with submitting..

FOR ALL ITEMS:
It should be noted that, as NRC staff review of this information is completed, additional technical details may be needed and subject to requests for additional information.

Buford, Angela

From: Buford, Angela
Sent: Tuesday, June 12, 2012 3:45 PM
To: Cook, William
Subject: Seabrook ASR Operability Inspection

Bill,

I spoke with Rich Conte this afternoon and he told me to give you my information in order to get badged/access at Seabrook. I'll be accompanying George Thomas from here at HQ next week, June 18-21.

If you are the correct contact, I will go ahead and send you the information to forward to the site, or I can contact the site representative directly.

I'll look forward to your response.

Thanks,

Angie Buford

Angela R. Buford | Structural Engineer
Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852
t: 301.415.3166
angela.buford@nrc.gov

Buford, Angela

From: Buford, Angela
Sent: Tuesday, June 12, 2012 2:02 PM
To: Thomas, George
Subject: Discuss Seabrook Audit

Hi George,

I work as a structural engineer in DLR and am going to be helping you on the Seabrook. I have a lot of experience in concrete degradation and have done structural design and analysis, including finite element modeling, so hopefully I will be a good addition to the team.

I'd like to coordinate reservation details with you for next week's inspection, so please contact me. My phone number is 415-3166.

Thanks,

Angela R. Buford | Structural Engineer
Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852
t: 301.415.3166
angela.buford@nrc.gov

Buford, Angela

From: Marshall, Michael
Sent: Friday, June 15, 2012 10:02 AM
To: Buford, Angela
Subject: RE: Do you still want me to come by re: Seabrook Inspection?

Angie,

Yes.

Michael

From: Buford, Angela
Sent: Friday, June 15, 2012 10:01 AM
To: Marshall, Michael
Subject: Do you still want me to come by re: Seabrook Inspection?

I'm not sure if you had more to discuss.

Angela R. Buford | Structural Engineer
Division of License Renewal
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U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852
t: 301.415.3166
angela.buford@nrc.gov

Buford, Angela

From: Marshall, Michael
Sent: Friday, June 29, 2012 8:46 AM
To: Buford, Angela
Subject: FW: Information Related to the Completion of CAL Items from June 30 FW: ASR Motar Bar Test
Attachments: SBK-L-12129 CAL No 8 Tech Dtls Large Scale Tests.pdf

Follow Up Flag: Follow up
Flag Status: Completed

From: Conte, Richard
Sent: Friday, June 29, 2012 8:37 AM
To: Burritt, Arthur; Cartwright, William; Chaudhary, Suresh; Cheok, Michael; Clifford, James; Cline, Leonard; Conte, Richard; Cook, William; Cruz, Holly; Cunanan, Arthur; Delligatti, Mark; Erickson, Alice; Evans, Michele; Galloway, Melanie; Hiland, Patrick; Jolicoeur, John; Khanna, Meena; Kobetz, Timothy; Lamb, John; Lubinski, John; Lund, Louise; Manoly, Kamal; Marshall, Michael; Merzke, Daniel; Miller, Chris; Morey, Dennis; Murphy, Martin; Nieh, Ho; Raymond, William; Roberts, Darrell; Sheikh, Abdul; Thomas, George; Wilson, Peter
Cc: Trapp, James
Subject: Information Related to the Completion of CAL Items fro June 30 FW: ASR Motar Bar Test

These relate to CAL Items 5, 6, and 8

CAL 5 is the update to POD for Extent of Conditions.

CAL 6 is Mortar Bar Test

From: Willoughby, Paul [mailto:Paul.Willoughby@fpl.com]
Sent: Thursday, June 28, 2012 1:00 PM
To: Conte, Richard; Cook, William; Chaudhary, Suresh; Thomas, George; Raymond, William
Cc: Noble, Rick; Collins, Michael; Brown, Brian; Vassallo, Theodore; OKeefe, Michael
Subject: ASR Motar Bar Test

FP 100734 ASR Testing - Stone (Motar Bar Test) has been uploaded to CERTREC.

POD update was uploaded earlier - AR 1664399 Prompt Operability Determination Rev 2

Paul Willoughby
Principal Nuclear Engineer
Licensing Department
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PO Box 300
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Cell: (207) 512-0362
Fax: (603) 773-7740
paul.willoughby@nexteraenergy.com

Buford, Angela

From: Buford, Angela
Sent: Wednesday, July 18, 2012 10:42 AM
To: Sheikh, Abdul; Conte, Richard; Cunanan, Arthur
Subject: RE: Seabrook Document

Those documents are not on the docket. Only the FP100716 the interim structural assessment is docketed. If you want that I can send it, otherwise you'll have to access the other documents on certrec.

From: Sheikh, Abdul
Sent: Tuesday, July 17, 2012 3:23 PM
To: Conte, Richard; Buford, Angela; Cunanan, Arthur
Subject: Seabrook Document

I am trying to find out if NextEra has submitted the following documents prepared by Professor Bayrak on the docket. I need to know this information because I need to share theses documents with our Contractor, Oak Ridge National Laboratory. I could not find these documents in the Adams. Of course these documents are available in Certrec.

The document is referenced in NextEra document SBK-L-12106 as follows:

9.5.1 "Structural implications of ASR: State of the Art," Bayrak, O., February 2012. (Seabrook FP No. 100697)
9.5.2 "Perspectives on ACT 318-71," Bayrak, 0. March 2012. (Seabrook FP No. 100717)

Abdul Sheikh

Buford, Angela

From: Buford, Angela
Sent: Friday, July 13, 2012 9:44 AM
To: Conte, Richard; Cook, William; Raymond, William; Chaudhary, Suresh
Subject: FYI

In efforts to keep the R1 inspection team in the loop, see below FYI regarding Oak Ridge contract to provide study on ASR

-----Original Message-----
From: Sheikh, Abdul
Sent: Thursday, July 12, 2012 4:49 PM
To: Buford, Angela
Subject: FW: J-4287, Task Order 13

-----Original Message-----
From: Naus, Dan J. [mailto:nausdj@ornl.gov]
Sent: Thursday, July 12, 2012 3:45 PM
To: Sheikh, Abdul
Subject: Re: J-4287, Task Order 13

Within four months of implementation of subcontract. Planned date was October 2012, but that was before our lawyers got involved.

Dan

From: <Sheikh>, Abdul <Abdul.Sheikh@nrc.gov<mailto:Abdul.Sheikh@nrc.gov>>
To: Dan Naus <nausdj@ornl.gov<mailto:nausdj@ornl.gov>>
Cc: "Erickson, Alice" <Alice.Erickson@nrc.gov<mailto:Alice.Erickson@nrc.gov>>, "Marshall, Michael" <Michael.Marshall@nrc.gov<mailto:Michael.Marshall@nrc.gov>>
Subject: J-4287, Task Order 13

There is a considerable pressure here to have progress on the Task Order 13 report since the scope of the task order includes the following items:

1. Approaches that can be used for determining the extent and the rate of current degradation in compressive, tensile, shear, and bond strengths, and Poisson's ratio of the ASR affected concrete shear walls and slab structures.
2. In-situ tests, laboratory tests or analytical methods that can be used to establish the current and future expansion of the ASR affected concrete.
3. The effects of ASR on the shear and tensile capacity of the anchor bolts and concrete anchors.
4. Laboratory tests, field tests, or analytical methods that can be used to determine the shear and tensile capacity of the anchor bolts and concrete anchors.
5. Approaches that can be used to determine the long-term degradation in compressive, tensile, shear, and bond strengths, and Poisson's ratio of the ASR affected concrete shear walls and slab structures after all the expansion has taken place.

6. The appropriate sampling plan for concrete cores (number and size of cores) from ASR degraded concrete for different types of tests.

7. Nonlinear finite element modeling methods used for the detailed structural evaluation of the ASR affected concrete structures.

Can you please let me know when a draft report will be submitted for this report.

Abdul

Buford, Angela

From: Buford, Angela
Sent: Friday, August 03, 2012 3:23 PM
To: Marshall, Michael
Subject: Comments on Dr. Harries' Report

Michael,

Since you were out of the office yesterday, Abdul Alice and I did not get to discuss with you our technical comments on Dr. Harries' report on ASR at Seabrook. I have my comments in bullet form on a Word document, but am unsure of the sensitivity of sending you the file by email. If you'd like me to send it, let me know, otherwise I'll wait and we can discuss a hard copy of the document.

Thanks

Angie

Marshall, Michael

From: Erickson, Alice
Sent: Tuesday, August 07, 2012 3:20 PM
To: Marshall, Michael
Subject: RE: Response Requested: Feedback to Region 1 on Contractor's ASR Paper

Michael,

Below are a few of the comments we discussed yesterday. I didn't include the statement about the FEA being vague because I was clear on the point he was trying to make.

Alice

From: Marshall, Michael
Sent: Tuesday, August 07, 2012 12:38 PM
To: Buford, Angela; Erickson, Alice; Sheikh, Abdul
Subject: Response Requested: Feedback to Region 1 on Contractor's ASR Paper

Hello Abdul, Alice, and Angie,

Per our discussion yesterday afternoon, please, provide examples to support each of the observations listed below:

Overall the paper is clear and well written. Because of the comments listed below, RASB believes the report prepared by Dr. Harries will need o be revised or a fuller discussion is needed among internal stakeholders regarding some of his observations prior to sharing the paper with licensee or other external stakeholders.

- Some of the position taken in the paper differ from current positions the staff has taken to date. If the intent is to use the paper as a basis for changing the current position, then a fuller discussion amongst the cognizant technical staff involved would be warranted. If the intent is not to change current position, then the paper could lead to undue confusion on the part of external stakeholders.
  - Examples:
  - On page 6, "The 25% 'potential strength reduction,' while conservative, is not warranted based on the data cited." The staff looks at this number in a "bounding" context, not actual.

- In several places in the paper, a qualified acceptance or temporary agreement is explicitly stated or implied. Typically, these statements are indicated by the phrase "at this time." A more full explanation seems warranted to explain why a qualified or temporary acceptance or agreement is merited and under what condition it would no longer be acceptable.
  - Examples:
  - On page 10, "Due to the nature of operational evaluation, I believe that applying the ACI 318-71 $V_c \leq 2\sqrt{f_c'}$ is appropriate and adequate for the Seabrook NSP structures ***at this time***, including those areas affected by ASR.
  - On page 11, "Based on the limited data available, the 40% reduction may be overly conservative ***at this time*** (extent of ASR deterioration).

- Some statements are broad, but it seems that the statement may have limited applicability (e.g., to a single structure). It may be beneficial to ensure broad statements are truly intended to be broad. If not then additional context should be provided.

- Examples:
- .....

If I have mischaracterized any of the main points, feel free to suggest alterative wording.

Michael L. Marshall, Jr.
Chief
Aging Management of Structures, Electrical, and Systems Branch
Division of License Renewal
Office of Nuclear Reactor Regulation

301-415-2871
Email: michael.marshall@nrc.gov

Marshall, Michael

From: Buford, Angela
Sent: Wednesday, August 08, 2012 10:25 AM
To: Marshall, Michael
Cc: Erickson, Alice; Sheikh, Abdul
Subject: FW: Response Requested: Feedback to Region 1 on Contractor's ASR Paper

Please see my additional comments below Abdul's in RED

From: Sheikh, Abdul
Sent: Wednesday, August 08, 2012 8:01 AM
To: Marshall, Michael; Buford, Angela; Erickson, Alice
Subject: RE: Response Requested: Feedback to Region 1 on Contractor's ASR Paper

---

From: Marshall, Michael
Sent: Tuesday, August 07, 2012 12:37 PM
To: Buford, Angela; Erickson, Alice; Sheikh, Abdul
Subject: Response Requested: Feedback to Region 1 on Contractor's ASR Paper

Hello Abdul, Alice, and Angie,

Per our discussion yesterday afternoon, please, provide examples to support each of the observations listed below:

> Overall the paper is clear and well written. Because of the comments listed below, RASB believes the report prepared by Dr. Harries will need o be revised or a fuller discussion is needed among internal stakeholders regarding some of his observations prior to sharing the paper with licensee or other external stakeholders.

- Some of the position taken in the paper differ from current positions the staff has taken to date. If the intent is to use the paper as a basis for changing the current position, then a fuller discussion amongst the cognizant technical staff involved would be warranted. If the intent is not to change current position, then the paper could lead to undue confusion on the part of external stakeholders.
  - o Examples: Professor Harries states that the 25% potential reduction for out of plane shear capacity of walls, while conservative, is not warranted based on data cited. The applicant has used this reduction based on published data after considerable discussion with the staff and the applicant's experts from MPR and University of Texas. Professor does not identify any data that has been cited.
  - o Dr. Harries' (referring to FP 100716 Section 3.1.2) states that ASR has not been conclusively established to have resulted in a reduction in in-situ compressive strength or modulus of elasticity. He also goes on, in the same section, to say that the reduction in modulus due to ASR is expected. It is misleading for the NRC endorse the statement, as there is considerable evidence in applicable research as well as in the licensee's testing that ASR has likely compromised the concrete material properties.

- In several places in the paper, a qualified acceptance or temporary agreement is explicitly stated or implied. Typically, these statements are indicated by the phrase "at this time." A more

full explanation seems warranted to explain why a qualified or temporary acceptance or agreement is merited and under what condition it would no longer be acceptable.

- Examples: Professor Harries states that due to nature of operational evaluation, I believe that applying the ACI 318-71 Vc = 2 sqrt Fc is appropriate and adequate for the Seabrook NPS structures at this time. Professor Harries does not identify explain the phrase "at this time"
- Dr. Harries, referring to FP 100716 Section 7, expresses concern regarding the applicant's seemingly haphazard anchor testing that was recently performed. He states that the pull-out testing may not be valid for the "Kwik bolts" because their performance relies on tightening torque and friction of the wedges, and the anchor tests using bolts that were installed post-ASR would not experience the same degradation as ones that were previously installed in concrete which developed and experienced the progression of ASR. He implies a qualified acceptance by adding that this issue could perhaps be addressed in the UT-A test program. His assessment begs the question, "is this acceptable?", and does not provide a definitive statement regarding whether the appropriate testing he alluded to is necessary or not.

- Some statements are broad, but it seems that the statement may have limited applicability (e.g., to a single structure). It may be beneficial to ensure broad statements are truly intended to be broad. If not then additional context should be provided.
  - Examples: Professor Harries states that use of finite element analyses to assess the effects of ASR has little practical value. This statement is too broad. FEA analysis of some structures is needed to determine the effects of ASR. For instance, parametric study of the containment enclosure building to determine the effect of reduced modulus of elasticity in needed,
  - .....

If I have mischaracterized any of the main points, feel free to suggest alterative wording.

Michael L. Marshall, Jr.
Chief
Aging Management of Structures, Electrical, and Systems Branch
Division of License Renewal
Office of Nuclear Reactor Regulation

301-415-2871
Email: michael.marshall@nrc.gov

Buford, Angela

From: Buford, Angela
Sent: Wednesday, August 08, 2012 10:25 AM
To: Marshall, Michael
Cc: Erickson, Alice; Sheikh, Abdul
Subject: FW: Response Requested: Feedback to Region 1 on Contractor's ASR Paper

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From: Sheikh, Abdul
Sent: Wednesday, August 08, 2012 8:01 AM
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B18

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Michael L. Marshall, Jr.
Chief
Aging Management of Structures, Electrical, and Systems Branch
Division of License Renewal
Office of Nuclear Reactor Regulation

301-415-2871
Email: michael.marshall@nrc.gov

Buford, Angela

From: Buford, Angela (NRR)
Sent: Thursday, August 09, 2012 9:54 AM
To: Cook, William
Subject: Status of FEA Comments on Seabrook ASR

Hi Bill,

I had more comments/issues than I anticipated, and some insights for your consideration (with every attempt to be brief and to the point.) I plan to have this to you no later than tomorrow.

Thanks,

Angie

Angela R. Buford | Structural Engineer
Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852
t: 301.415.3166
angela.buford@nrc.gov

Buford, Angela

From: Buford, Angela NRR
Sent: Thursday, August 09, 2012 9:54 AM
To: Cook, William
Subject: Status of FEA Comments on Seabrook ASR

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I had more comments/issues than I anticipated, and some insights for your consideration (with every attempt to be brief and to the point.) I plan to have this to you no later than tomorrow.

Thanks,

Angie

Angela R. Buford | Structural Engineer
Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852
t: 301.415.3166
angela.buford@nrc.gov

Marshall, Michael

From: Sheikh, Abdul
Sent: Thursday, August 16, 2012 10:37 AM
To: Galloway, Melanie
Cc: Conte, Richard; Marshall, Michael
Subject: Seabrook ASR - Executive Briefing and Deviation Memo

Rich Conte provided the following information:

1. Executive briefing is scheduled for August 28 at 4:00 PM. He told me that you have already accepted the briefing meeting notice. The briefing is in accordance with the ASR working group charter
2. The Region wanted to have the briefing before Eric Leeds review the Basis for Deviation Memo for ROP. The memo is scheduled for Eric Leeds review August 30-31, 2012.
3. Proposed topics for Executive Briefing
   a. Basis for deviation memo with ROP. Rich Conte told me that DLR is not normally involved with this.
   b. Status of CAL items and staff review
   c. Outstanding issues
   d. Plans for testing at University of Texas at Austin

Let me know if you need any additional information.

Marshall, Michael

From: Galloway, Melanie
Sent: Tuesday, September 04, 2012 1:00 PM
To: Leeds, Eric
Cc: Boger, Bruce; Nieh, Ho; Marshall, Michael; Lubinski, John
Subject: RE: Region I Deviate

Eric,

DLR did not have any issue with the Seabrook ROP deviation proposed by Region I and approved by you.

As far as a timeline for ASR resolution in LR (based on our understanding of the applicant's path forward and what we at this time understand to be necessary to resolve the issue), the applicant informed the NRC in a public meeting on April 23 that its ASR test program would not be complete until Summer 2014. So assuming that we are provided high quality responses to our questions in LR quickly (a fairly large supposition), the earliest that we would be able to close the issue would be Fall 2014. That is the best we have as of now in terms of a timeline.

We will keep you informed as information on this issue develops.

Melanie

From: Leeds, Eric
Sent: Friday, August 31, 2012 1:23 PM
To: Galloway, Melanie; Nieh, Ho
Cc: Boger, Bruce
Subject: Region I Deviate

Melanie & Ho –

I read the proposed memo for the Seabrook ROP deviation from Region I and my gut reaction is to support it. My only concern is the length of time it will take to come to a conclusion on ASR. Do we have a timeline on the path and does DLR and DPR support the deviation?

Eric J. Leeds, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
301-415-1270

Marshall, Michael

From: Buford, Angela
Sent: Thursday, September 06, 2012 6:54 AM
To: Marshall, Michael
Subject: CAL Items for First Inspection/Report
Attachments: CAL ML12125A172.pdf - Adobe Acrobat Pro.pdf

Michael, for Seabrook first inspection report, the Region plans to address CAL items 1-5, as highlighted in the attached document.

Marshall, Michael

From: Heater, Keith
Sent: Friday, September 07, 2012 3:18 PM
To: RidsEdoMailCenter Resource; Dean, Bill; Lew, David; Roberts, Darrell; Clifford, James; Miller, Chris; Wilson, Peter; Trapp, James; Burritt, Arthur; Raymond, William; Jennerich, Matthew; McCree, Victor; Casto, Chuck; Collins, Elmo; Brenner, Eliot; Lamb, John; Khanna, Meena; Giitter, Joseph; Galloway, Melanie; Lund, Louise; Evans, Michele; Hiland, Patrick; Nieh, Ho; Franovich, Rani; Cheok, Michael; Boger, Bruce; Brown, Frederick; Leeds, Eric; Kobetz, Timothy; Marshall, Michael; Murphy, Martin; Kennedy, Silas; Powell, Amy; McGinty, Tim
Cc: Matakas, Gina; ODaniell, Cynthia; Bearde, Diane; Cass, Andrea; McNamara, Nancy; Tifft, Doug; Screnci, Diane; Sheehan, Neil; Conte, Richard; Cline, Leonard; Turilin, Andrey; Chernoff, Harold; Morey, Dennis; Manoly, Kamal; Cook, William; Thompson, Margaret; Pinkham, Laurie; Greives, Jonathan; Dunham, Katrina
Subject: Approved: REQUEST FOR DEVIATION FROM THE REACTOR OVERSIGHT PROCESS ACTION MATRIX TO PROVIDE INCREASED OVERSIGHT OF THE ALKALI-SILICA REACTION ISSUE AT SEABROOK
Attachments: Deviation Memo Seabrook ASR F DIRS.docx

To ALL;

Attached is the approved memorandum; "REQUEST FOR DEVIATION FROM THE REACTOR OVERSIGHT PROCESS ACTION MATRIX TO PROVIDE INCREASED OVERSIGHT OF THE ALKALI-SILICA REACTION ISSUE AT SEABROOK," dated September 5, 2012.

Seabrook Deviation Memo
Package: ML12242A363
Memo: ML12242A370

This approved Reactor Oversight Process Deviation Memorandum request will allow for increased NRC oversight of activities related to the alkali-silica reaction (ASR) issue at Seabrook Station. This will permit staff to devote additional inspection and assessment resources (hours and samples) to review licensee commitments and planned large-scale concrete specimen testing, to develop staff technical guidance, and support stakeholder communication and outreach activities.

Point of Contact: Richard Conte, RI, DRS, (610) 337-5183

Thank you.

- Keith Heater, Lead Admin.
Region-I, DRP
610-337-5384

"Mission, Vision, Values
MV^2 – Taking the Right Actions
in the Right Direction
to achieve
Our Shared Goals."

Buford, Angela

From: Marshall, Michael
Sent: Tuesday, September 11, 2012 8:03 AM
To: Sheikh, Abdul; Erickson, Alice; Buford, Angela
Subject: FYI: Draft Agenda for the CNSC-NRC Technical Exchange Meeting on ASR Effects in Concrete, September 20th @ 1:00 p.m. CSB Room 4C-19
Attachments: Regulatory Approach to ASR.docx

From: Conte, Richard
Sent: Tuesday, September 11, 2012 7:34 AM
To: Marshall, Michael; Ott, William
Cc: Philip, Jacob; Nicholson, Thomas; Murphy, Martin; Graves, Herman; Trapp, James; Burritt, Arthur; Khanna, Meena; Lamb, John; Milano, Patrick; Morey, Dennis
Subject: RE: Draft Agenda for the CNSC-NRC Technical Exchange Meeting on ASR Effects in Concrete, September 20th @ 1:00 p.m. CSB Room 4C-19

Here is what I would send to our friends in Canada. Even if the material was publicly released there should not be any surprises.

I would hope the whole session covers the attached questions that each regulatory should be able to respond to by way of open exchange (not specifically the 20 minutes session for Abdul and I).

From: Marshall, Michael
Sent: Wednesday, September 05, 2012 2:21 PM
To: Ott, William
Cc: Philip, Jacob; Nicholson, Thomas; Conte, Richard; Murphy, Martin
Subject: RE: Draft Agenda for the CNSC-NRC Technical Exchange Meeting on ASR Effects in Concrete, September 20th @ 1:00 p.m. CSB Room 4C-19

Hello Bill,

I have talked with Marty, but I have not talked with Rich, yet. Marty and I can support the exchange on September 20, 2012. We have not decided who will speak. Marty will be out of the office and will need to participate in the exchange remotely.

Michael L. Marshall, Jr.
Chief
Aging Management of Structures, Electrical, and Systems Branch
Division of License Renewal
Office of Nuclear Reactor Regulation

301-415-2871
Email: michael.marshall@nrc.gov

From: Ott, William
Sent: Wednesday, August 29, 2012 4:29 PM
To: Marshall, Michael; Conte, Richard
Cc: Philip, Jacob; Nicholson, Thomas
Subject: FW: Draft Agenda for the CNSC-NRC Technical Exchange Meeting on ASR Effects in Concrete, September 20th @ 1:00 p.m. CSB Room 4C-19

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Mike and Richard,

We have been in contact with the Canadians and developed a draft agenda for the information exchange on ASR. We are still adjusting the times they have suggested because they are proposing three presentations from their University of Toronto contractors for a total of 45 minutes with somewhat less time for the introductory remarks. The NRC contribution is more speculative because we have not found the opportunity to discuss it with you yet. Jake has spoken to the NIST investigators and they have agreed to their part. Would you like to propose a time tomorrow or Friday to discuss the remainder of the agenda? We have listed some tentative participants but you may wish to make changes. It shouldn't take long to complete. I am unavailable on Thursday from 3:00 to 4:00 and Friday from 10:30 to 11:30 but otherwise available. Just give me sufficient time to check with Tom and Jake.

Bill

From: Nicholson, Thomas
Sent: Thursday, August 23, 2012 5:40 PM
To: Rinker, Michael; kenneth.snyder@nist.gov; Orbovic, Nebojsa; Philip, Jacob
Cc: Ott, William; Coe, Doug; Sangimino, Donna-Marie; Correia, Richard
Subject: Draft Agenda for the CNSC-NRC Technical Exchange Meeting on ASR Effects in Concrete, September 20th @ 1:00 p.m. CSB Room 4C-19

Mike, Jake, Ken, Nebojsa:

Please review the attached agenda, and send me any edits and/or modifications you have by Monday, August 27th.

Thanks ..... Tom

****

Thomas J. Nicholson, Senior Technical Advisor
U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Mail Stop CSB 2-A07
11555 Rockville Pike
Rockville, MD 20852
Tel: (301) 251-7498
Fax: (301) 251-7422
E-mail: Thomas.Nicholson@nrc.gov

****

From: Conte, Richard
To: Hughey, John
Subject: RE: ACTION: Urgent - Seabrook Charter
Date: Tuesday, September 11, 2012 5:12:32 PM

You want to be on distribution for ASR working group stuff.

From: Hughey, John
Sent: Tuesday, September 11, 2012 4:45 PM
To: Bearde, Diane; Lamb, John
Cc: Lee, Erika; Pinkham, Laurie; Conte, Richard; Khanna, Meena
Subject: RE: ACTION: Urgent - Seabrook Charter

Diane,
John Lamb is the primary PM for Seabrook and I am the backup. We will make sure the appropriate e-mail gets to ADAMS IM to request public release for Friday, 9/14.

Thanks,
John Hughey

From: Bearde, Diane
Sent: Tuesday, September 11, 2012 12:05 PM
To: Hughey, John; Lamb, John
Cc: Lee, Erika; Pinkham, Laurie; Conte, Richard
Subject: ACTION: Urgent - Seabrook Charter
Importance: High

Good Afternoon,

I am writing to request your assistance.

Region I is about to issue the Seabrook Deviation Memo transmittal letter to NextEra on the ASR topic. One of the several documents (the SAITT Charter, ADAMS Accession No. ML121250588) that is referenced in this letter is currently non-public and will need to become public in ADAMS. As authors and project managers of the document, the ADAMS IM group needs an email from you saying that the document has been SUNSI reviewed and should be set for release on Friday, September 14, 2012. The ADAMS IM group has requested that this email come from John Hughey, but it may actually be required of John Lamb - which is why both of you are being addressed on this email.

For your information, all of the Seabrook ASR documents are contained in package ML12242A363.

Please let me know if you have any questions or need more information regarding this request. In my absence, please call Laurie Pinkham (610) 337-5133.

Diane Bearde
Division of Reactor Safety
U.S. Nuclear Regulatory Commission
(610) 337-5191

B-7.6

From: Khanna, Meena
To: Hughey, John
Subject: RE: ACTION: Urgent - Seabrook Charter
Date: Tuesday, September 11, 2012 6:35:00 PM

Thanks John

From: Hughey, John
Sent: Tuesday, September 11, 2012 4:45 PM
To: Bearde, Diane; Lamb, John
Cc: Lee, Erika; Pinkham, Laurie; Conte, Richard; Khanna, Meena
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Diane Bearde
Division of Reactor Safety
U.S. Nuclear Regulatory Commission
(610) 337-5191

Buford, Angela

From: Marshall, Michael
Sent: Wednesday, September 12, 2012 7:10 AM
To: Erickson, Alice; Sheikh, Abdul; Buford, Angela
Cc: Murphy, Martin
Subject: RE: RESPONSE: Latest Drafts of the Rebar and Core Sampling Position Papers

Alice, Angie, and Abdul,

It is not our position, yet. And if it is incorrect, it will not be our position. The comments were/are being circulated to ensure they reflect our best technical position. I am trying to echo and document the various things that I have been told or learned from the three of you. Let's meet this morning, so I can learn what I may have miss understood.

However, I am not inclined to wait for response from the applicant in order for us to provide our – not the applicants - best technical advice to the region on what action should or should not be imposed on the licensee.

Michael L. Marshall, Jr.
Chief
Aging Management of Structures, Electrical, and Systems Branch
Division of License Renewal
Office of Nuclear Reactor Regulation

301-415-2871
Email: michael.marshall@nrc.gov

From: Erickson, Alice
Sent: Tuesday, September 11, 2012 4:08 PM
To: Sheikh, Abdul; Marshall, Michael; Buford, Angela
Cc: Murphy, Martin
Subject: RE: RESPONSE: Latest Drafts of the Rebar and Core Sampling Position Papers

Michael,

As Abdul highlighted, we are asking a question related to the first bullet under Rebar Paper. I'm not sure we (license renewal) should provide such a strong position on this point until the applicant has provided it's response, and we have had time to evaluate it. Additionally, I'm not sure that that I entirely agree with the first statement of the second bullet under the Core Sampling Paper. This is new information to me and I wasn't aware that that was our position.

Alice

From: Sheikh, Abdul
Sent: Tuesday, September 11, 2012 1:05 PM
To: Marshall, Michael; Buford, Angela; Erickson, Alice
Cc: Murphy, Martin
Subject: RE: RESPONSE: Latest Drafts of the Rebar and Core Sampling Position Papers

Following are my observations for your consideration:
Rebar Paper:

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Cc: Marshall, Michael
Subject: Containment Issue at Seabrook

Rich, in response to the current situation and your request for technical opinion of the NRR staff, My comments are below.

- The primary containment has cracking in excess of the IWL (by reference to ACI 349.3R) criteria for cracking. The licensee has informed the NRC that its ASR monitoring program, which includes all structures including containment, uses visual indication to detect the presence of ASR and monitor/measure progression of ASR through crack indexing. There are a number of structures being monitored. While not all have had petrographic examinations, all have been "assumed" to be affected by ASR, including the containment. The licensee has asserted that its program would not and cannot "take a structure out of the program" unless it is verified not to have ASR, and the licensee has indicated that its program is conservative in that it assumes all structures with ASR-indicative cracking are indeed ASR. The containment is included in this program, and has visual indications of ASR (currently the only method used to determine the presence of ASR). It is well known that ASR produces an expansive gel and ASTM tests done by the licensee indicate that the aggregates continue to be reactive, in which case in an engineering evaluation it must be assumed that the ASR gel will continue to expand, making the cracks ACTIVE as opposed to passive. The fact that there are two locations where these active cracks exceed the width criteria for passive cracking is of concern, and it is unconservative to assume otherwise.

- The licensee is bound to ASME IWL-2510 which requires surface examination in accordance with ACI 201.1 and ACI 349.3R. For active cracks, ACI 349.3R puts you into chapter 5.3, "Conditions requiring further evaluation" and requires the use of nondestructive testing or other analytical method to determine acceptance.

- Since it is understood that ASR causes the degradation of material properties of concrete, and the criteria for an operability determination is whether the material properties are affected, it is unconservative to assume there is no degradation in material properties, especially since this has been observed elsewhere on site. It is my thinking that the licensee would have to demonstrate that the material properties remain within its CLB (the ACI 318 limits). If not, it is outside of its CLB and would have to perform a proper technical evaluation (and not a technical paper pointing to historical evidence in South Africa and Japan... There is also plenty of literature to the opposite effect showing structures degrading beyond their load-carrying capabilities) A technical evaluation should be based upon and relevant to the current structure/concrete/conditions, and should be in some way quantitative.

Angela R. Buford | Structural Engineer
Division of License Renewal
Office of Nuclear Reactor Regulation
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11555 Rockville Pike
Rockville, MD 20852
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angela.buford@nrc.gov

indications of corrosion is effective and should provide sufficient time for the licensee to take corrective action. The occurrence of ASR will not prevent or impede the detection of those visual indications.

- Analysis of groundwater: The purpose of conducting additional groundwater analysis is unclear. If the intent is to determine whether conditions are present to cause ASR, we already know the answer is yes. If the intent is to determine whether the structure is in an aggressive environment, we already know the answer is yes. Given that the structures are known to be susceptible to ASR and the environment is aggressive, it would be expected that frequency of inspections conducted as part of the structure monitoring program (or ASR monitoring program) would increase beyond the norm. We are unsure if the progress or rate of ASR can be determined from an analysis of the groundwater.

Core Sampling Paper

- Confirmation of structural integrity: RASB does not believe taking and testing additional core bores will establish a suitable basis to determine the strength of the structure. Such test would only provide determination of the material properties of the concrete but may not be representative of the properties of the structure. If the concrete was not effected by concrete and known relationships were still valid, it would be acceptable to treat the properties of material as a surrogate for the structure.

- Establish an accurate baseline: RASB does believe additional core samples should be taken to confirm the licensees assertion that the ASR is worse in the electrical tunnel. The use of core bores to confirm the ASR and to compare the severity of ASR from one location to another location would be one means to verify the acceptability of use one or a limited number of locations to trend the effect of ASR. The occurrence or pattern of cracking due to ASR on the surface of a structure may vary depending of several factors (e.g., ...[Angie fill in].....). Therefore, non-visual examination of the suspected area may be necessary to verify that areas identified as worst affected are truly worse effected.

- Other: Although the paper did not propose comparison of the concrete at the site with the tests that licensee plans to conduct, it seems as part of the licensees effort to demonstrate the applicability of the material and the condition of the material (e.g., artificial aging or recreation of ASR) that additional cores of affected areas would be taken to compare to the cores taken from the test members to verify that the test members accurately reflect the concrete at the site.

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Please note that in one of the RAIs being sent to the applicant, the request is as follows:

a. Discuss any plans to expose additional areas of ASR affected concrete, and describe how these areas will be inspected and monitored for corrosion and loss of bond during the period of extended operation.
b. Describe how the embeds and anchors in the ASR affected structures will be inspected and monitored during the period of extended operation.

Core Sampling Paper

As a part of contract J-4287, Task Order 13, we have asked ORNL and University of California to identify the following:

1. Approaches that can be used for determining the extent and the rate of current degradation in compressive, tensile, shear, and bond strengths, and Poisson's ratio of the ASR affected concrete shear walls and slab structures.
2. In-situ tests, laboratory tests or analytical methods that can be used to establish the current and future expansion of the ASR affected concrete.
3. The effects of ASR on the shear and tensile capacity of the anchor bolts and concrete anchors.
4. Laboratory tests, field tests, or analytical methods that can be used to determine the shear and tensile capacity of the anchor bolts and concrete anchors.
5. Approaches that can be used to determine the long-term degradation in compressive, tensile, shear, and bond strengths, and Poisson's ratio of the ASR affected concrete shear walls and slab structures after all the expansion has taken place.
6. The appropriate sampling plan for concrete cores (number and size of cores) from ASR degraded concrete for different types of tests.

We will get a draft report from University of California by end of October, 2012.

From: Marshall, Michael
Sent: Tuesday, September 11, 2012 11:55 AM
To: Sheikh, Abdul; Buford, Angela; Erickson, Alice
Cc: Murphy, Martin
Subject: RESPONSE: Latest Drafts of the Rebar and Core Sampling Position Papers

Hello Abdul, Alice, and Angie,

Please, review the response that I plan to send to Bill Cook on behalf of RASB per our discussion yesterday. Please, let me know if you disagree, even in the slightest, with the statements below. Please, correct technical inaccuracy and mischarterizations.

Below are RASB's comments on the rebar and core sampling papers. RASB did not offer specific edits are comments on portion of the paper, but overarching comments related to the recommendations in each of the papers.

Rebar Paper

- Sampling of rebar: RASB does not believe it is necessary on a sampling basis to expose and exam rebar. RASB does agree that the condition of the concrete (i.e., ASR-related cracking) and the aggressive environment that some of the structures are exposed may increase the problems listed in the paper. Our understanding is that the plant has a current structure monitoring program that includes inspection of the surface of the concrete for visual indications (e.g., spalling, staining) of corrosion of the rebar. Inspection of the concrete surface for visual

From: Bearde, Diane
To: Hughey, John; Conte, Richard
Cc: Lee, Erika; Pinkham, Laurie; Khanna, Meena; Lamb, John
Subject: RE: ACTION: Urgent - Seabrook Charter
Date: Wednesday, September 12, 2012 8:34:24 AM

Good Morning, John.

We have had success in writing to the Document Processing Center (aka John Repetto) to confirm the release date of these types of documents involved with communication plans. We always receive a confirmation and have not experienced any problems with our requests. My intent is to follow-up on this document with the Doc Processing Center to confirm the release date.

Please include me on your email to ADAMS IM regarding the SUNSI review/release and that will be my prompt to get in touch with the Doc Processing Center.

If you disagree with this approach, please let me know and we can work it out.

Thanks,
Diane

Diane Bearde
Division of Reactor Safety
U.S. Nuclear Regulatory Commission
(610) 337-5191

From: Hughey, John
Sent: Wednesday, September 12, 2012 8:26 AM
To: Conte, Richard
Cc: Lee, Erika; Pinkham, Laurie; Khanna, Meena; Lamb, John; Bearde, Diane
Subject: RE: ACTION: Urgent - Seabrook Charter

Hi Rich,
I just spoke with John Lamb and he confirmed that he will take care of the e-mail to ADAMS once he has done a SUNSI review and determined that the charter does not contain sensitive information.

Another issue John will raise with you is the timing of the release. We have found it challenging in the past to specify a future release date for a classification change (as opposed to the issuance of a new document) and have all the necessary steps proceed as intended. Therefore, John Lamb will also be asking you if there is any problem with going ahead a asking ADAMs to make the document public immediately.

Thanks,
John

John Hughey
Salem & Hope Creek Project Manager
NRR / Division of Operating Reactor Licensing
Phone: 301-415-3204
e-mail: John.Hughey@nrc.gov

From: Hughey, John
Sent: Tuesday, September 11, 2012 4:45 PM
To: Bearde, Diane; Lamb, John
Cc: Lee, Erika; Pinkham, Laurie; Conte, Richard; Khanna, Meena
Subject: RE: ACTION: Urgent - Seabrook Charter

Diane,
John Lamb is the primary PM for Seabrook and I am the backup. We will make sure the appropriate e-mail gets to ADAMS IM to request public release for Friday, 9/14.

Thanks,
John Hughey

From: Bearde, Diane
Sent: Tuesday, September 11, 2012 12:05 PM
To: Hughey, John; Lamb, John
Cc: Lee, Erika; Pinkham, Laurie; Conte, Richard
Subject: ACTION: Urgent - Seabrook Charter
Importance: High

Good Afternoon,

I am writing to request your assistance.

Region I is about to issue the Seabrook Deviation Memo transmittal letter to NextEra on the ASR topic. One of the several documents (the SAITT Charter, ADAMS Accession No. ML121250588) that is referenced in this letter is currently non-public and will need to become public in ADAMS. As authors and project managers of the document, the ADAMS IM group needs an email from you saying that the document has been SUNSI reviewed and should be set for release on Friday, September 14, 2012. The ADAMS IM group has requested that this email come from John Hughey, but it may actually be required of John Lamb - which is why both of you are being addressed on this email.

For your information, all of the Seabrook ASR documents are contained in package ML12242A363.

Please let me know if you have any questions or need more information regarding this request. In my absence, please call Laurie Pinkham (610) 337-5133.

Diane Bearde
Division of Reactor Safety
U.S. Nuclear Regulatory Commission
(610) 337-5191

From: Raymond, William (NRO)
To: Greives, Jonathan
Cc: Dunham, Katrina; Jennerich, Matthew; Cline, Leonard; Hughey, John; Burritt, Arthur
Subject: RE: Branch 3 Status
Date: Wednesday, September 12, 2012 5:52:07 PM

The ACRS cancelled for October 2012 due to an internal conflict on their end, and is tentatively rescheduling for Spring 2013.
Bill

From: Greives, Jonathan (R1)
Sent: Thursday, August 02, 2012 10:47 AM
To: Burritt, Arthur
Cc: Dunham, Katrina; Jennerich, Matthew; Raymond, William; Cline, Leonard; Hughey, John
Subject: RE: Branch 3 Status

Additional item for the status sheet (sorry if you're already aware of the item):

Seabrook is coordinating an ACRS site visit for the 1st week of October (during RFO) with focus on containment liner and ASR. SB expects ~7 people in attendance. Kent Howard is the ACRS staff POC coordinating with SB.

From: Burritt, Arthur (R1)
Sent: Thursday, August 02, 2012 10:18 AM
To: Bower, Fred; Cline, Leonard; Dunham, Katrina; Greives, Jonathan; Hughey, John; Jennerich, Matthew; Khanna, Meena; Lamb, John; McKenna, Philip; Montgomery, Richard; Raymond, William; Schroeder, Daniel; Scrabeck, Brian; Turilin, Andrey; Williams, Christopher; Wilson, George
Subject: Branch 3 Status

See attached

From: Conte, Richard
To: Bearde, Diane; Hughey, John
Cc: Lee, Erika; Pinkham, Laurie; Khanna, Meena; Lamb, John
Subject: RE: ACTION: Urgent - Seabrook Charter
Date: Wednesday, September 12, 2012 7:36:05 PM

Ok now to release immediately.

From: Bearde, Diane
Sent: Wednesday, September 12, 2012 8:36 AM
To: Hughey, John; Conte, Richard
Cc: Lee, Erika; Pinkham, Laurie; Khanna, Meena; Lamb, John
Subject: RE: ACTION: Urgent - Seabrook Charter

Also, Rich Conte is in a Senior Management Retreat again today – if you need anything, or specifically, Rich – please let me know. I can get to him – I am also the lead admin on this Seabrook project. Thanks - Diane

---

From: Hughey, John
Sent: Wednesday, September 12, 2012 8:26 AM
To: Conte, Richard
Cc: Lee, Erika; Pinkham, Laurie; Khanna, Meena; Lamb, John; Bearde, Diane
Subject: RE: ACTION: Urgent - Seabrook Charter

Hi Rich,
I just spoke with John Lamb and he confirmed that he will take care of the e-mail to ADAMS once he has done a SUNSI review and determined that the charter does not contain sensitive information.

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John Hughey
Salem & Hope Creek Project Manager
NRR / Division of Operating Reactor Licensing
Phone: 301-415-3204
e-mail: John.Hughey@nrc.gov

From: Hughey, John
Sent: Tuesday, September 11, 2012 4:45 PM
To: Bearde, Diane; Lamb, John
Cc: Lee, Erika; Pinkham, Laurie; Conte, Richard; Khanna, Meena
Subject: RE: ACTION: Urgent - Seabrook Charter

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Thanks,
John Hughey

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Sent: Tuesday, September 11, 2012 12:05 PM
To: Hughey, John; Lamb, John
Cc: Lee, Erika; Pinkham, Laurie; Conte, Richard
Subject: ACTION: Urgent - Seabrook Charter
Importance: High

Good Afternoon,

I am writing to request your assistance.

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For your information, all of the Seabrook ASR documents are contained in package ML12242A363.

Please let me know if you have any questions or need more information regarding this request. In my absence, please call Laurie Pinkham (610) 337-5133.

Diane Bearde
Division of Reactor Safety
U.S. Nuclear Regulatory Commission
(610) 337-5191

From: Lamb, John NRR
To: ADAMS IM
Cc: Conte, Richard; Khanna, Meena; Hughey, John; Bearde, Diane
Subject: For Your Action - Seabrook Working ASR Team Charter (ML121250588)
Date: Wednesday, September 12, 2012 8:35:36 AM
Importance: High

Dear ADAMS IM:

Currently, the Seabrook Alkali-Silica Reaction (ASR) Issue Technical Team (SAITT) charter, dated July 9, 2012 (ML121250588) is not available to the public.

I performed a SUNSI review of ML121250588 and it does not contain any sensitive unclassified non-safeguards information. Please make the SAITT charter, dated July 9, 2012 (ML121250588) is **available to the public**.

Thanks.
John

Marshall, Michael

From: Erickson, Alice
Sent: Monday, September 17, 2012 11:35 AM
To: Thomas, George
Cc: Murphy, Martin; Marshall, Michael
Subject: Draft - Applicability of ACI 318
Attachments: ASR White Paper - 10 CFR Part 50.docx

Good Morning George,

I have been asked to circulate this paper to the ASR working group; however, I would first like to get your comments. A lot of the information you have already seen because it was originally part of the Part 50/Part 54 paper. That paper has now been split in two and this portion is supposed to address the applicability of ACI 318. Please review and provide me your comments.

Thanks,

Alice Erickson
General Engineer
NRR/DLR/RASB

Mail Stop: O-11F1
Phone: (301) 415-1933
Email: Alice.Erickson@NRC.gov

Marshall, Michael

From: Erickson, Alice
Sent: Tuesday, September 18, 2012 9:17 AM
To: Sheikh, Abdul; Buford, Angela
Cc: Marshall, Michael
Subject: Questions for ACI 318 Code Committee

Angie and Abdul,

I am going to be asking ACI questions related to ASR and the Code requirements to further develop the paper I am writing. Before these questions get passed on to the ASR working group, Michael asked that I get input from you and ask if you have any further questions you would like answered. Please provide me with any comments on the draft questions below or new questions by COB today.

Thanks,

Alice

Draft Questions

1. Can you provide clarification as to who is considered the "sponsors" of any system of design, and who is considered the "building official?" Nuclear Power Plants are sometimes designed in accordance with ACI 318. Although the Agency hasn't adopted the ACI 318 code, it was endorsed through a Regulatory Guide which is not required to be met. However, if a plant incorporates the ACI 318 Code into their Final Safety Analysis Report, the NRC is allowed to enforce the requirements of this Code.
2. If there is doubt that a part or all of a structure meets the safety requirements of the Code (i.e. concrete degradation due to alkali-silica reaction), are the provisions provided in Chapter 20 the best approach for assessing the structure or is there guidance that would better suit this situation?
3. Are there any provisions of ACI 318 that would allow model testing to demonstrate that an existing structure affected by ASR still meets the Code requirements?

Alice Erickson
General Engineer
NRR/DLR/RASB

Mail Stop: O-11F1
Phone: (301) 415-1933
Email: Alice.Erickson@NRC.gov

Buford, Angela

From: Raymond, William NRO
Sent: Wednesday, September 26, 2012 5:59 PM
To: Conte, Richard; Buford, Angela
Cc: Raymond, William
Subject: Re: Containment Issue at Seabrook

Thank you, Angie. I agree with the logic you laid out and I could use that framework to show how regulatory and NextEra procedure requirements would necessitate an operability determination be completed for the degraded containment conditions.
Bill

Sent via NRC BlackBerry

From: Conte, Richard R1
To: Burritt, Arthur; Cook, William; Khanna, Meena; Lamb, John; Marshall, Michael; Milano, Patrick; Morey, Dennis; Murphy, Martin; Trapp, James
Cc: Raymond, William; Chaudhary, Suresh
Sent: Wed Sep 26 17:26:06 2012
Subject: FW: Containment Issue at Seabrook

I appreciate Angie's advice. I am almost there but I would like to caucus tomorrow after NextEra gives their logic.

I need to go to a session tomorrow from 200pm to 300pm so my earliest would be 300-400p or 400-500pm for caucus, if necessary we may need to more it to Monday afternoon.

I will set up a bridge for caucus time anywhere from 100pm to 600pm.

From: Buford, Angela NRR
Sent: Wednesday, September 26, 2012 4:11 PM
To: Conte, Richard
Cc: Marshall, Michael
Subject: Containment Issue at Seabrook

Rich, in response to the current situation and your request for technical opinion of the NRR staff, My comments are below.

- The primary containment has cracking in excess of the IWL (by reference to ACI 349.3R) criteria for cracking. The licensee has informed the NRC that its ASR monitoring program, which includes all structures including containment, uses visual indication to detect the presence of ASR and monitor/measure progression of ASR through crack indexing. There are a number of structures being monitored. While not all have had petrographic examinations, all have been "assumed" to be affected by ASR, including the containment. The licensee has asserted that its program would not and cannot "take a structure out of the program" unless it is verified not to have ASR, and the licensee has indicated that its program is conservative in that it assumes all structures with ASR-indicative cracking are indeed ASR. The containment is included in this program, and has visual indications of ASR (currently the only method used to determine the presence of ASR). It is well known that ASR produces an expansive gel and ASTM tests done by the licensee indicate that the aggregates continue to be reactive, in which case in an engineering evaluation it must be assumed that the ASR gel will

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continue to expand, making the cracks ACTIVE as opposed to passive. The fact that there are two locations where these active cracks exceed the width criteria for passive cracking is of concern, and it is unconservative to assume otherwise.

- The licensee is bound to ASME IWL-2510 which requires surface examination in accordance with ACI 201.1 and ACI 349.3R. For active cracks, ACI 349.3R puts you into chapter 5.3, "Conditions requiring further evaluation" and requires the use of nondestructive testing or other analytical method to determine acceptance.

- Since it is understood that ASR causes the degradation of material properties of concrete, and the criteria for an operability determination is whether the material properties are affected, it is unconservative to assume there is no degradation in material properties, especially since this has been observed elsewhere on site. It is my thinking that the licensee would have to demonstrate that the material properties remain within its CLB (the ACI 318 limits). If not, it is outside of its CLB and would have to perform a proper technical evaluation (and not a technical paper pointing to historical evidence in South Africa and Japan... There is also plenty of literature to the opposite effect showing structures degrading beyond their load-carrying capabilities) A technical evaluation should be based upon and relevant to the current structure/concrete/conditions, and should be in some way quantitative.

Angela R. Buford | Structural Engineer
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U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852
t: 301.415.3166
angela.buford@nrc.gov

Marshall, Michael

From: Sheikh, Abdul
Sent: Thursday, September 27, 2012 8:07 AM
To: Marshall, Michael
Subject: FW: Containment Issue at Seabrook

I have some input as marked below.

From: Conte, Richard
Sent: Thursday, September 27, 2012 7:37 AM
To: Raymond, William; Marshall, Michael; Murphy, Martin
Cc: Buford, Angela; Chaudhary, Suresh; Cook, William; Erickson, Alice; Trapp, James; Burritt, Arthur; Thomas, George; Sheikh, Abdul
Subject: RE: Containment Issue at Seabrook

I am looking to the future right now, when the dust clears we can go historically and with findings.

Some questions I plan to get clarified today on the status call (conference no and pass code still coming):

1. Is there a difference in the IWL implementing procedure and the SMP implementing procedure.

As far as I remember, there is no difference in implementing procedures for AMPs for containment (IWL) and other structures (SMP).

2. If no NOW to Q1, then when did the primary containment come under the fold of the SMP and is it compliant with ASME 2004 IWL.
3. If yes NOW to Q1, then has the IWL implementing procedure been upgraded since October 2010 when they did there supposedly baseline review per SER (which I am sure was in the RAI response) and this revision should have included ASR issues when the SMP was updated per CAL.

I am not aware of any change in implementing procedures since our audit. The applicant on May 16, 2012 submitted a special supplementary AMP for ASR. The scope of this new supplementary program includes assessment of containment and containment enclosure building for ASR.

4. Have they taken any exceptions to the ACI 349.3R section 5 on evaluation criteria in the past or NOW. Same question as applied to the whole document. [Important to note that IWL requires inspection of sufficient detail to id..... as described in ACI 201.1 and 349.3R. It does say they must use it but if they haven't taken any exceptions in the ISI program or QA plan them I would enforce now the section 5 criteria for startup as not being of "sufficient detail."

I am not aware of the applicant taking exception to Section 5.0 (5.1, 5.2, and 5.3) of the ACI 349.3R

5. Do we know of any crack widths on Primary Containment that exceed the Tr 2 (>= 15 mills) and Tr 3 (>=40 mils) action levels of ACI 349.3R? CCI did not go into effect until July 2012, as best I know now.

In the March 30, 2012 letter, the applicant stated that the cracks in the containment are less than 15 mils. Therefore, no further action is required. However, the staff contention is that these cracks are not passive and are due to ASR. The applicant stated that these cracks could be due to ASR. Since the cracks are active (not passive) the ACI 349.3R section 5.1 require that these cracks need to be evaluated.

Marty and Michael, you and your staff are my technical main stay. I appreciate what Angie has compiled thus far, some clarifications are need.

Where I am headed is that any Tr 2 and Tr 3 action of ACI on primary containment (actual crack widths NOT CCI unless it is truly applicable now)must be addressed as they reflect degradation that warrant an engineering evaluation/OD. I will need to commitment to do it by restart in writing.

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It does not matter if the cracks are TR1, TR2, and TR3. The cracks are due to ASR and are active (not passive). Therefore, and evaluation (operability evaluation) is required.

I am out on a limb, I need your advice.

From: Raymond, William
Sent: Wednesday, September 26, 2012 7:16 PM
To: Conte, Richard
Cc: Buford, Angela
Subject: RE: Containment Issue at Seabrook

Rich,
I did a crack index calculation for the containment at MF102-01 azimuth 270 degrees and validated the high CI values documented by SGH in FP100738 (Line item 14).
I used the SGH crack data (page A17) and procedures (FP100647/SGH Z004-11) to calculate a CCI of 1.42 mm/m, which is comparable to the MPR value of 1.675 mm/m and the SGH value of 1.72 mm/m. I am still reviewing my calculations to close the gap between my answer and SGH's.

In any case, the CI values exceed the criteria of 1 mm/m for which a structural evaluation should be completed per NexEra's Structure's Monitoring procedure EDS 36180.

Using the logic and framework outlined by Angie (below), I could write an violation to the effect that NextEra had data indicating a degraded and nonconforming condition existed for the containment, but NextEra failed to evaluate the condition in an operability determination per EN-203-1001, "Operability Determinations and Functionality Assessments."

We can talk more tomorrow. Let me know if you need more details.
Bill

From: Conte, Richard
Sent: Wednesday, September 26, 2012 5:26 PM
To: Burritt, Arthur; Cook, William; Khanna, Meena; Lamb, John; Marshall, Michael; Milano, Patrick; Morey, Dennis; Murphy, Martin; Trapp, James
Cc: Raymond, William; Chaudhary, Suresh
Subject: FW: Containment Issue at Seabrook

I appreciate Angie's advice. I am almost there but I would like to caucus tomorrow after NextEra gives their logic.

I need to go to a session tomorrow from 200pm to 300pm so my earliest would be 300-400p or 400-500pm for caucus, if necessary we may need to more it to Monday afternoon.

I will set up a bridge for caucus time anywhere from 100pm to 600pm.

From: Buford, Angela
Sent: Wednesday, September 26, 2012 4:11 PM
To: Conte, Richard

Cc: Marshall, Michael
Subject: Containment Issue at Seabrook

Rich, in response to the current situation and your request for technical opinion of the NRR staff, My comments are below.

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Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
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Rockville, MD 20852
t: 301.415.3166
angela.buford@nrc.gov

Marshall, Michael

From: Murphy, Martin
Sent: Thursday, September 27, 2012 6:24 AM
To: Marshall, Michael
Subject: RE: Containment Issue at Seabrook

I generally agree. I think the last bullet may go a little too far with regard to our current understanding. Timeliness question is not addressed; perhaps by design. Based the licensees contention and I would say backed up to some extent, by our own contractor, there is a possible state where gel formation may actually result in improved material properties. This isn't considered in the response. Also, operability determinations are allowed to rely on engineering judgment and don't necessarily need to "demonstrate". Simply pointing to the previous test results with some understanding of equivalent visual evidence should be enough for an operability determination.

From: Marshall, Michael
Sent: Wednesday, September 26, 2012 4:26 PM
To: Murphy, Martin
Subject: FW: Containment Issue at Seabrook

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To: Conte, Richard
Cc: Marshall, Michael
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B57

- Since it is understood that ASR causes the degradation of material properties of concrete, and the criteria for an operability determination is whether the material properties are affected, it is unconservative to assume there is no degradation in material properties, especially since this has been observed elsewhere on site. It is my thinking that the licensee would have to demonstrate that the material properties remain within its CLB (the ACI 318 limits). If not, it is outside of its CLB and would have to perform a proper technical evaluation (and not a technical paper pointing to historical evidence in South Africa and Japan... There is also plenty of literature to the opposite effect showing structures degrading beyond their load-carrying capabilities) A technical evaluation should be based upon and relevant to the current structure/concrete/conditions, and should be in some way quantitative.

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Buford, Angela

From: Marshall, Michael
Sent: Thursday, September 27, 2012 8:03 AM
To: Buford, Angela
Subject: Heads-Up: Containment Issue at Seabrook

Angie,

Please, stop by to chat. Nothing bad.

Michael

From: Marshall, Michael
Sent: Thursday, September 27, 2012 7:50 AM
To: Murphy, Martin
Subject: RE: Containment Issue at Seabrook

Hello Marty,

With regard to the last bullet, I think both the licensee and us have been using the literature in somewhat selective manner. From talking with my staff, I get the strong sense the literature is mixed. We can find information both support and refute the licensee's position or own positions. I do not believe neither us of the licensee has made a sufficient effort to demonstrate the literature that we point to is applicable to Seabrook (e.g., similar reinforcement, cement, purpose, etc). I will circle back with Angie to discuss "in some way quantitative." I do not think she meant to preclude the use of engineering judgment.

We (my staff and I) agree that ASR initially can improve some properties, but over time and by the time the process is completed, it will degrade properties. I think we tend to default to the long-term, versus now, and no one seems to have a handle on what stage of the ASR lifecycle for the different structures. This is point that warrants clarification and consistently pointing out how the effect of ASR can vary during its lifecycle. Like the literature, the license and us tend to point to the end of the lifecycle that supports our position without making an effort to demonstrate that stage of the ASR lifecycle is applicable to the structure that we have an interest.

With regards to operability determinations, further evaluations, and engineering evaluations, I think we starting to use the terms interchangeably, but there are meaningful difference, especially with regards to operability determination. I do not think an operability determination has to be further evaluation as defined by the ACI standards or an engineering evaluation. This is how I see the ASR issue at Seabrook. Setting aside whether the licensee should or should not conduct a separate operability determination for the containment for a moment. The point of the last bullet was intended to convey this – not preclude the exercise of judgment, instead using the other structures as an example. Seabrook has a prompt operability determination for structures that we initially identified with ASR that we have accepted. Seabrook is planning to conduct test and engineering evaluations that is intended to confirm or revise the prompt operability determination, which would also satisfy Seabrook's obligation to conduct further evaluations. According to my understanding of Seabrook's plans, this will not be completed until mid to late 2014. This is how I see the interaction of operability determinations, further evaluations, and engineering evaluations in this case. This predates my time in the branch, I believe the operability determination was not prompted merely by the presence of ASR, but the testing of the core bores that should a substantial decree in concrete- not structure – mechanical properties.

B3,8

Back to the containment, the question we are helping the Region pursue is whether a separate operability determination or any operability determination needs to be conducted for the containment beyond what has been conducted for other structures. I get the impression that the licensee's position is that ASR in and of itself is not sufficient to compel them to conduct an operability determination. The applicant is declining to take and test cores from the containment. The results of similar tests in other structures prompted the operability determination for those structures. Another, albeit indirect, way of making argument that a separate operability determination needs to be done is to pursue the plant's implementation of IWL program. Specifically, having the licensee, consistent with their own program, conduct a further evaluation of the acceptability of the cracks. The result of this further evaluation like the results of the tests on the core bores would then prompt the licensee to conduct a separate operability determination. Considering that ASR can effect structures differently (e.g., degree of cracking) and the significant of the containment, I think a separate operability determination may be warranted. However, that would more than likely merely put the containment on the same path as the other structures, with the same question of timeliness of actions by the licensee's and by the NRC.

We did not address the timeliness question in Angie's response, I think that is subject that the responsible BCs should address at our next Seabrook ASR Team meeting.

Best Regards,

Michael L. Marshall, Jr.
Chief
Aging Management of Structures, Electrical, and Systems Branch
Division of License Renewal
Office of Nuclear Reactor Regulation

301-415-2871
Email: michael.marshall@nrc.gov

From: Murphy, Martin
Sent: Thursday, September 27, 2012 6:24 AM
To: Marshall, Michael
Subject: RE: Containment Issue at Seabrook

I generally agree. I think the last bullet may go a little too far with regard to our current understanding. Timeliness question is not addressed; perhaps by design. Based the licensees contention and I would say backed up to some extent, by our own contractor, there is a possible state where gel formation may actually result in improved material properties. This isn't considered in the response. Also, operability determinations are allowed to rely on engineering judgment and don't necessarily need to "demonstrate". Simply pointing to the previous test results with some understanding of equivalent visual evidence should be enough for an operability determination.

From: Marshall, Michael
Sent: Wednesday, September 26, 2012 4:26 PM
To: Murphy, Martin
Subject: FW: Containment Issue at Seabrook

From: Buford, Angela
Sent: Wednesday, September 26, 2012 4:11 PM
To: Conte, Richard

Marshall, Michael

From: Murphy, Martin
Sent: Thursday, September 27, 2012 8:16 AM
To: Marshall, Michael
Subject: RE: Containment Issue at Seabrook

Hi Mike,

I think we continue to be on the same page. I have no issue with the need for an operability determination on the containment structure. I don't think it would be significantly different from what they already have done. Further, I think you are spot on that both the licensee and the staff are selectively using literature and data to support their relative positions. I think we are smarter than that and simply need to put in sufficient time rather than being reactive. The licensee has a lot of work to do for its testing program and to demonstrate its applicability to site conditions. This will take time also. I was really just trying request caution wrt responses that could be read by those who want to fuel the reactive fire vice employing a more cerebral approach.

Thanks, Marty

From: Marshall, Michael
Sent: Thursday, September 27, 2012 7:50 AM
To: Murphy, Martin
Subject: RE: Containment Issue at Seabrook

Hello Marty,

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839

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Best Regards,

Michael L. Marshall, Jr.
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Division of License Renewal
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301-415-2871
Email: michael.marshall@nrc.gov

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To: Marshall, Michael
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From: Marshall, Michael
Sent: Wednesday, September 26, 2012 4:26 PM
To: Murphy, Martin
Subject: FW: Containment Issue at Seabrook

From: Buford, Angela
Sent: Wednesday, September 26, 2012 4:11 PM
To: Conte, Richard
Cc: Marshall, Michael
Subject: Containment Issue at Seabrook

Rich, in response to the current situation and your request for technical opinion of the NRR staff, My comments are below.

- The primary containment has cracking in excess of the IWL (by reference to ACI 349.3R) criteria for cracking. The licensee has informed the NRC that its ASR monitoring program, which includes all structures including containment, uses visual indication to detect the presence of ASR and monitor/measure progression of ASR through crack indexing. There are a number of structures being monitored. While not all have had petrographic examinations, all have been "assumed" to be affected by ASR, including the containment. The licensee has asserted that its program would not and cannot "take a structure out of the program" unless it is verified not to have ASR, and the licensee has indicated that its program is conservative in that it assumes all structures with ASR-indicative cracking are indeed ASR. The containment is included in this program, and has visual indications of ASR (currently the only method used to determine the presence of ASR). It is well known that ASR produces an expansive gel and ASTM tests done by the licensee indicate that the aggregates continue to be reactive, in which case in an engineering evaluation it must be assumed that the ASR gel will continue to expand, making the cracks ACTIVE as opposed to passive. The fact that there are two locations where these active cracks exceed the width criteria for passive cracking is of concern, and it is unconservative to assume otherwise.

- The licensee is bound to ASME IWL-2510 which requires surface examination in accordance with ACI 201.1 and ACI 349.3R. For active cracks, ACI 349.3R puts you into chapter 5.3, "Conditions requiring further evaluation" and requires the use of nondestructive testing or other analytical method to determine acceptance.

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Marshall, Michael

From:	Miskey, Cheryl
Sent:	Thursday, September 27, 2012 1:23 PM
To:	R1ORAMAIL RESOURCE; R1DRPMAIL RESOURCE; Miller, Chris; Wilson, Peter; Burritt, Arthur; Chaudhary, Suresh; Cline, Leonard; Conte, Richard; Raymond, William; Giitter, Joseph; Lamb, John; Miller, Barry; Cruz, Holly; Galloway, Melanie; Hiland, Patrick; Khanna, Meena; Manoly, Kamal; Thomas, George; Marshall, Michael; Morey, Dennis; Sheikh, Abdul; Cunanan, Arthur; Ferrer, Nathaniel; Bearde, Diane
Subject:	WITHDRAWAL OF REQUEST FOR TECHNICAL ASSISTANCE - SEABROOK STATION ALKALI-SILICA REACTION
Attachments:	Memo To Rescind TIA QuestionsFINAL.docx

WITHDRAWAL OF REQUEST FOR TECHNICAL ASSISTANCE - SEABROOK STATION ALKALI-SILICA REACTION, dated 9/27/12.
ADAMS Accession No. ML12271A295

View ADAMS P8 Properties ML12271A295
Open ADAMS P8 Document (Withdrawal of Request for Technical Assistance - Seabrook Station Alkali-Silica Reaction)

Cheryl M. Miskey
Administrative Assistant, RI/DRS
(610) 337-5277
Email: Cheryl.Miskey@nrc.gov

B40

Thomas, George

From: Thomas, George (NRO)
Sent: Sunday, September 30, 2012 8:02 PM
To: Conte, Richard
Cc: Buford, Angela; Chaudhary, Suresh; Murphy, Martin; Raymond, William
Subject: RE: Containment Issue at Seabrook

Rich,

I searched on ADAMS for Seabrook ISI Summary report submittal from Sep 2009 onward and could not find any that included containment ISI summary . I guess, IWA-6000 can be read as requiring it only for Class 1 and 2 components. However, containment inservice inspection reports/records are required to be maintained at the site. Attached is the Containment ISI Plan that I found for the Second 10-year interval that began Aug 2010, if it is of any help.
Thanks.

George

From: Conte, Richard (RC)
Sent: Thursday, September 27, 2012 7:37 AM
To: Raymond, William; Marshall, Michael; Murphy, Martin
Cc: Buford, Angela; Chaudhary, Suresh; Cook, William; Erickson, Alice; Trapp, James; Burritt, Arthur; Thomas, George; Sheikh, Abdul
Subject: RE: Containment Issue at Seabrook

I am looking to the future right now, when the dust clears we can go historically and with findings.

Some questions I plan to get clarified today on the status call (conference no and pass code still coming):

1. Is there a difference in the IWL implementing procedure and the SMP implementing procedure.
2. If no NOW to Q1, then when did the primary containment come under the fold of the SMP and is it compliant with ASME 2004 IWL.
3. If yes NOW to Q1, then has the IWL implementing procedure been upgraded since October 2010 when they did there supposedly baseline review per SER (which I am sure was in the RAI response) and this revision should have included ASR issues when the SMP was updated per CAL.
4. Have they taken any exceptions to the ACI 349.3R section 5 on evaluation criteria in the past or NOW. Same question as applied to the whole document. (Important to note that IWL requires inspection of sufficient detail to id..... as described in ACI 201.1 and 349.3R. It does say they must use it but if they haven't taken any exceptions in the ISI program or QA plan them I would enforce now the section 5 criteria for startup as not being of "sufficient detail."
5. Do we know of any crack widths on Primary Containment that exceed the Tr 2 (>= 15 mills) and Tr 3 (>=40 mils) action levels of ACI 349.3R? CCI did not go into effect until July 2012, as best I know now.

Marty and Michael, you and your staff are my technical main stay. I appreciate what Angie has compiled thus far, some clarifications are need.

Where I am headed is that any Tr 2 and Tr 3 action of ACI on primary containment (actual crack widths NOT CCI unless it is truly applicable now)must be addressed as they reflect degradation that warrant an engineering evaluation/OD. I will need to commitment to do it by restart in writing.

B41

I am out on a limb, I need your advice.

From: Raymond, William
Sent: Wednesday, September 26, 2012 7:16 PM
To: Conte, Richard
Cc: Buford, Angela
Subject: RE: Containment Issue at Seabrook

Rich,
I did a crack index calculation for the containment at MF102-01 azimuth 270 degrees and validated the high CI values documented by SGH in FP100738 (Line item 14).
I used the SGH crack data (page A17) and procedures (FP100647/SGH Z004-11) to calculate a CCI of 1.42 mm/m, which is comparable to the MPR value of 1.675 mm/m and the SGH value of 1.72 mm/m. I am still reviewing my calculations to close the gap between my answer and SGH's.

In any case, the CI values exceed the criteria of 1 mm/m for which a structural evaluation should be completed per NexEra's Structure's Monitoring procedure EDS 36180.

Using the logic and framework outlined by Angie (below), I could write an violation to the effect that NextEra had data indicating a degraded and nonconforming condition existed for the containment, but NextEra failed to evaluate the condition in an operability determination per EN-203-1001, "Operability Determinations and Functionality Assessments."

We can talk more tomorrow. Let me know if you need more details.
Bill

From: Conte, Richard
Sent: Wednesday, September 26, 2012 5:26 PM
To: Burritt, Arthur; Cook, William; Khanna, Meena; Lamb, John; Marshall, Michael; Milano, Patrick; Morey, Dennis; Murphy, Martin; Trapp, James
Cc: Raymond, William; Chaudhary, Suresh
Subject: FW: Containment Issue at Seabrook

I appreciate Angie's advice. I am almost there but I would like to caucus tomorrow after NextEra gives their logic.

I need to go to a session tomorrow from 200pm to 300pm so my earliest would be 300-400p or 400-500pm for caucus, if necessary we may need to more it to Monday afternoon.

I will set up a bridge for caucus time anywhere from 100pm to 600pm.

From: Buford, Angela
Sent: Wednesday, September 26, 2012 4:11 PM
To: Conte, Richard
Cc: Marshall, Michael
Subject: Containment Issue at Seabrook

Rich, in response to the current situation and your request for technical opinion of the NRR staff, My comments are below.

- The primary containment has cracking in excess of the IWL (by reference to ACI 349.3R) criteria for cracking. The licensee has informed the NRC that its ASR monitoring program, which includes all structures including containment, uses visual indication to detect the presence of ASR and monitor/measure progression of ASR through crack indexing. There are a number of structures being monitored. While not all have had petrographic examinations, all have been "assumed" to be affected by ASR, including the containment. The licensee has asserted that its program would not and cannot "take a structure out of the program" unless it is verified not to have ASR, and the licensee has indicated that its program is conservative in that it assumes all structures with ASR-indicative cracking are indeed ASR. The containment is included in this program, and has visual indications of ASR (currently the only method used to determine the presence of ASR). It is well known that ASR produces an expansive gel and ASTM tests done by the licensee indicate that the aggregates continue to be reactive, in which case in an engineering evaluation it must be assumed that the ASR gel will continue to expand, making the cracks ACTIVE as opposed to passive. The fact that there are two locations where these active cracks exceed the width criteria for passive cracking is of concern, and it is unconservative to assume otherwise.

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U.S. Nuclear Regulatory Commission
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Rockville, MD 20852
t: 301.415.3166
angela.buford@nrc.gov

Buford, Angela

From: Buford, Angela
Sent: Friday, October 05, 2012 9:58 AM
To: Thomas, George
Cc: Cook, William
Subject: RE: Evaluation of FP-100716

Also – the first bullet has to do with the issue of shear capacity and Seabrook using 50% margin in the code. Maybe you can provide some better verbiage for the staff position on that, since it was one of the issues you had also raised onsite regarding the use of Dr. Bayrak's data.

From: Buford, Angela
Sent: Friday, October 05, 2012 9:55 AM
To: Thomas, George
Cc: Cook, William
Subject: FW: Evaluation of FP-100716

George,

Attached are the comments I sent Bill Cook on FP 100716, the Seabrook Interim Structural Evaluation. Can you please review and advise on whether you think something is off the mark or in your opinion mischaracterized.

I think Bill is going to touch base with you at some point in the near future as well.

Thanks,

Angie

From: Buford, Angela
Sent: Tuesday, October 02, 2012 3:37 PM
To: Cook, William
Cc: Conte, Richard; Raymond, William
Subject: Evaluation of FP-100716

Bill,

Attached are my comments on the structural evaluation, FP 100716 Seabrook response to CAL. Previously I sent you specific comments on the Finite Element Analysis performed as the Bounding Evaluation for the Containment Enclosure Building specifically. The comments on/evaluation of the FEA model for the CEB I sent previously should act as a supplement to this document.

Also - I touch on it briefly in the attached comments, but there is more to come on the adequacy of crack mapping/visual examination for characterizing and monitoring progression of ASR. I'm working on a technical position paper on that subject.

Thanks,

Angie

B.2.

Buford, Angela

From: Buford, Angela
Sent: Friday, October 05, 2012 9:55 AM
To: Thomas, George
Cc: Cook, William
Subject: FW: Evaluation of FP-100716
Attachments: Notes on FP 100716 Rev.docx

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Angie

Notes on FP 100716

- Shear Capacity/Margin: The licensee states that ACI 318-71 includes 50% margin on shear capacity for components up to two feet thick. This is not valid, as ACI 318-71 assumes concrete has not been affected by ASR. The licensee cannot assume that the relationships in the design code are still valid. However, the research has shown that 25% decrease in shear capacity is a conservative estimate, given the relatively mild level of current ASR degradation at Seabrook.

- Lap Splice Strength: There are 47 evaluations that show concrete to have "insufficient margin to accommodate ASR" based on a 40% reduction in lap splice strength, but the licensee states that the use of a 40% reduction is not appropriate. They cite, qualitatively, reasons why 40% should not be used: The licensee stated that the pullout test method is "outdated" and "known to be unrealistic". If there is much relevant information that shows the pullout test is unrealistic, the licensee should have a way to quantify the error of using the pullout test method and apply the error in order to obtain a "usable" value. Also, licensee stated "The test used reinforcing steel much smaller than typical reinforcing steel used at Seabrook Station. Reinforcement anchorage is known as a limit state that does not scale well". Need information to back up that statement. The design of lap splices is based on area of steel that is in contact with the concrete and the bond between concrete and steel (which is reduced with ASR, as the concrete often tends to crack along the length of the rebar). The assertion that reinforcing bar size does not scale well to lap splice strength needs adequate technical justification. The evaluation states that the testing used to obtain this data was targeted to advanced levels of ASR degradation. There is no information to demonstrate the level of ASR distress in the specimens used in the test, but it is agreed that Seabrook ASR is not far advanced, so maybe the rationale is okay for this interim assessment.

- Anchor bolt testing – licensee performed testing on anchor bolts post installed into concrete girders at Ferguson lab. While the testing provides some insights into the behavior of anchors at Seabrook, the data is incomplete as it used anchors that were installed into concrete that was already affected by ASR, while the anchors at Seabrook were already installed when the ASR started. The reduction in capacity was 16% for the anchors tested as part of this program. Given some margin in the design, we can live with this for now. It would not be suitable for a long-term operability determination because the ASR mechanism occurring after anchors were installed into the originally ASR-free concrete means that the anchors have potentially "loosened" during the reaction, whereas post-installed anchors drilled into the concrete for testing purposes here would potentially perform better because they can achieve a tighter "grip" into the concrete and thus have a higher pullout strength.

- Section 3.1.1, Petrographic Examination – the licensee stated that it performed petrographic examinations on sections of three 16" cores from the interior face of the B Electrical Tunnel wall. Licensee did petrographic analysis of the cores and noted that

there was a higher degree of ASR cracking in the samples near the exposed interior wall surfaces. The licensee was not able to say definitively that there is only ASR occurring outside of the rebar cage. Either way, this note should be minimized in our determination of the suitability of this engineering evaluation because there have been instances where the relative humidity inside the concrete causes ASR to occur (sometimes to a distressed state) while the outside concrete is not affected. The point is that this may be a case where the licensee has a favorable data point (i.e., one set of three cores taken from the same location of one affected structure that appears to show that ASR is minimal inside the rebar cage) but no grounds besides that to assert that ASR is only really prevalent in cover concrete (which is what they are implying). The licensee often states this in discussions on ASR and it might be worth highlighting that we have no basis by which to agree with this. Along the same line, it may be worth highlighting that the licensee has implied through this demonstration (and research also shows) that visual indications alone may not be the most effective way to measure ASR degradation and that for the current program and long term operation, it will be necessary to have petrographic analysis (i.e., more core samples) of important structures to verify the extent of ASR degradation as opposed to solely relying upon visual examination that has the potential to give specious results.

- Mechanical Testing of Concrete Cores –

    - Cores applicability to Concrete Strength: Research shows that concrete strengths obtained from the original cylinders that were prepared on site should not be used as the original in situ concrete strength. According to research, "core tests [in general, not specific to ASR] cannot be translated to terms of standard cylinder strength with any degree of confidence", meaning that concrete cylinders that were prepared when the concrete was poured usually show a higher 28-day strength value than what really exists in situ. The cylinders are only used as a measure to demonstrate that concrete has attained sufficient strength to remove forms, or to show that the concrete is not significantly below its design strength. This thought yields two consequences:
        - 1. It may not be valuable to attribute 28-day cylinder testing results to the "original design strength" of the concrete and apply it to make a determination of how much concrete strength has been "lost" since it was poured.
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Notes on FP 100716

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Buford, Angela

From: Buford, Angela
Sent: Tuesday, October 09, 2012 11:43 AM
To: Marshall, Michael
Subject: RE: FP100716 - ASR Degraded Areas Not Evaluated

Michael,

When you say I am "participating", are you referring to

1. Review of OD on containment (to be submitted by licensee approx 10/15)
2. Attendance to final week of inspection and outbrief (week of 10/22 @ Seabrook)

Or both?

I was a little bit confused with the correspondence.

Thanks,

Angie

From: Marshall, Michael
Sent: Friday, October 05, 2012 9:50 AM
To: Conte, Richard
Cc: Murphy, Martin; Buford, Angela
Subject: RE: FP100716 - ASR Degraded Areas Not Evaluated

Rich,

Yes, Angie can participate.

Michael

From: Conte, Richard
Sent: Thursday, October 04, 2012 5:54 PM
To: Cook, William; Raymond, William; Murphy, Martin; Marshall, Michael
Cc: Buford, Angela; Thomas, George; Chaudhary, Suresh; Burritt, Arthur; Khanna, Meena; Lamb, John; Morey, Dennis; Milano, Patrick; Trapp, James
Subject: RE: FP100716 - ASR Degraded Areas Not Evaluated

Expanding to the branch Chiefs and others in NRR.

Also this reminds me that primary containment has one area with a CCI > 1.5mm/m yet no evaluation was done except what they are planning on doing by next Friday Oct. 12 – Operability Determination.

We will need to have the team dedicate time, most likely Monday and Tuesday Oct. 15 and 16 to do an initial cut review. If we need licensee to make a presentation on what they are doing it might be best to schedule it after the initial review like 1030 on Oct. 17 so that we can ask intelligent questions. Bill Cook and I will be up at the site the week of 10/22 tentatively for Report No. 1 outbrief.

Marty and Michael can at least Angie participate and perhaps she can consult with George and Abdul.

My management is expecting a initial "look-see" before the plant starts up.

From: Cook, William
Sent: Thursday, October 04, 2012 5:16 PM
To: Raymond, William; Conte, Richard
Cc: Buford, Angela; Thomas, George; Chaudhary, Suresh; Burritt, Arthur
Subject: RE: FP100716 - ASR Degraded Areas Not Evaluated

Thanks for the update Bill.
Bill C.

From: Raymond, William
Sent: Thursday, October 04, 2012 5:00 PM
To: Conte, Richard; Cook, William
Cc: Buford, Angela; Thomas, George; Chaudhary, Suresh
Subject: FP100716 - ASR Degraded Areas Not Evaluated

Art & Bill,
I talked to Brian Brown this afternoon regarding my question of last week - Specifically, those plant areas (24-11=13) discussed on page 15 of the Interim Assessment (FP100716, MPR-3704) with a CCI >1.0 but <1.5 mm/m that have not been evaluated. Brian said that no CR has been written but he will write one to track the issue and to get the areas into a process. Brian acknowledges that the degraded areas meet the criteria in the SMP requiring a structural evaluation and the need to do so has been discussed with Rick Noble. I told Brian we intend to add this as a topic for discussion during the next bi-weekly call between NRC and the station.
Bill

Buford, Angela

From: Marshall, Michael
Sent: Tuesday, October 09, 2012 1:10 PM
To: Buford, Angela
Subject: RE: FP100716 - ASR Degraded Areas Not Evaluated

Hello Angie,

I was referring to review of the OD. Just in case, call Bill Cook and ask if the R1 wants your onsite support for the week of 10/22. Thanks.

Michael

From: Buford, Angela
Sent: Tuesday, October 09, 2012 11:43 AM
To: Marshall, Michael
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Subject: RE: FP100716 - ASR Degraded Areas Not Evaluated

B44

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Bill

Buford, Angela

From: Buford, Angela
Sent: Wednesday, October 10, 2012 8:28 AM
To: Marshall, Michael
Subject: RESPONSE REQUESTED: Week of 10/22 (Seabrook Inspection)

Michael, see Bill and Rich's comments below. I'll leave the final decision up to you.

From: Conte, Richard
Sent: Tuesday, October 09, 2012 4:05 PM
To: Cook, William; Buford, Angela
Subject: RE: Week of 10/22

The more the merrier. Another brain is always helpful especially on this issue and in discussion with NextEra.

From: Cook, William
Sent: Tuesday, October 09, 2012 4:03 PM
To: Buford, Angela
Cc: Conte, Richard
Subject: RE: Week of 10/22

Angie,
I am in favor of your support. By copy I will ask Rich.
Bill

From: Buford, Angela
Sent: Tuesday, October 09, 2012 1:35 PM
To: Cook, William
Subject: Week of 10/22

Hi Bill,

Last week we had discussed me potentially supporting you and Rich at your last week of the 10/22 inspection at Seabrook. I am able to, if you and Rich would need me, but if not, I won't plan on coming. Let me know either way!

Also, I have not heard back from George, but today I am (working from home but) circulating my comments to Abdul and Alice to get a license renewal perspective to make sure we are all aligned. Hopefully I will have comments soon.

Thanks,

Angie

B45

Buford, Angela

From: Buford, Angela
Sent: Thursday, October 11, 2012 9:24 AM
To: Erickson, Alice
Subject: FW: Evaluation of FP-100716
Attachments: Notes on FP 100716 Rev.docx

Alice,

Can you look at these comments and let me know if you believe something may not jive with DLR staff's position or understanding in terms of the LR review. As we discussed, if you can respond by early next week, I'd appreciate it!

Thanks,

Angie

From: Buford, Angela
Sent: Friday, October 05, 2012 9:55 AM
To: Thomas, George
Cc: Cook, William
Subject: FW: Evaluation of FP-100716

George,

Attached are the comments I sent Bill Cook on FP 100716, the Seabrook Interim Structural Evaluation. Can you please review and advise on whether you think something is off the mark or in your opinion mischaracterized.

I think Bill is going to touch base with you at some point in the near future as well.

Thanks,

Angie

From: Buford, Angela
Sent: Tuesday, October 02, 2012 3:37 PM
To: Cook, William
Cc: Conte, Richard; Raymond, William
Subject: Evaluation of FP-100716

Bill,

Attached are my comments on the structural evaluation, FP 100716 Seabrook response to CAL. Previously I sent you specific comments on the Finite Element Analysis performed as the Bounding Evaluation for the Containment Enclosure Building specifically. The comments on/evaluation of the FEA model for the CEB I sent previously should act as a supplement to this document.

B46

Also - I touch on it briefly in the attached comments, but there is more to come on the adequacy of crack mapping/visual examination for characterizing and monitoring progression of ASR. I'm working on a technical position paper on that subject.

Thanks,

Angie

Notes on FP 100716

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From: Khanna, Meena
To: Blumberg, Mark
Cc: Tate, Travis; Ruland, William
Subject: FW: Seabrook CEEACS LAR Review - Pros and Cons Associated with Options for Path Forward
Date: Friday, October 12, 2012 7:30:45 PM
Attachments: Comparison Pro-Con Table - Seabrook CEEACS LAR Review Rev 6.docx
Importance: High

Hi Mark,

I met with Bill Ruland today, and he asked that I touch base with you to see if you could pls review the attached table and provide any additions to the pros/cons, as necessary. If you could please send your input to all of the parties involved, by Tuesday afternoon, that would be greatly appreciated. Pls note that I did speak to Travis and he agreed that this should be a priority wrt your other work.

Thanks so much for your continued support and have a nice weekend!

Meena

From: Khanna, Meena
Sent: Wednesday, October 10, 2012 4:17 PM
To: Ruland, William
Cc: Lund, Louise; Coffin, Stephanie; Evans, Michele; Lamb, John; Ennis, Rick; Schulten, Carl; Walker, Harold; Tate, Travis; Elliott, Robert; Blumberg, Mark; Giitter, Joseph; Lee, Samson
Subject: Seabrook CEEACS LAR Review - Pros and Cons Associated with Options for Path Forward

Hi Bill,

As requested, attached is the consolidated table of pros and cons associated with the Seabrook CEEACS LAR review, regarding the three options that have been identified as path forward to address the issue associated with failure of the door. Pls. note that we will need to clearly articulate how we define a "failed door" to the licensee, because there may be some confusion between the staff and licensee on the definition of a failed door. My understanding is that the staff is defining a failed door as when the door is off its hinges or broken.

The three options for path forward for a "failed door" include: (1) 24 hour AOT to fix the door, (2) 8 hour AOT for corrective maintenance to fix the door, or (3) proceed to 3.0.3 (shutdown) to fix the door. All divisions/branches associated with the review in DORL, DSS, and DRA have provided input. However, we will need to reach out to Mark Blumberg to ensure that we obtain his feedback, as well.

As you already know, but I do want to note, that all branches/divisions are all in alignment with the 8 hours for preventive maintenance for the door seals, hardware, etc.

Please give me a call if you have any questions or if you would like for us to schedule any meetings with the staff and/or licensee.

Thanks again for your continued support,

Meena

B4-1

Seabrook CEEACS LAR Review

Requested Action: Please identify pros and cons of the various options associated with the failure of the door with regards to the Seabrook CEEACS review.

NOTE: Assume the Seabrook TS are realigned by (1) moving the CEB drawdown test from TS 3.6.5.1 to the CEB integrity spec 3.6.5.2; (2) adding a CEB TS action to allow 8 hours for preventative maintenance of door hardware and seals; and (3) adding a 24 hour AOT for the door propped open for equipment ingress and egress provided compensatory measures are established.

I. ***Pros of Options Associated with Failure of the Door****, i.e., a loss of Function Condition in TS 3.6.5.2 for one access opening door inoperable for other than preventative maintenance or for planned equipment ingress or egress.*

Option 1: 24 hour AOT	**Option 2: 8 hour AOT (Corrective Maintenance)**	**Option 3: Proceed Directly to 3.0.3**
DORL: 24 hours to restore containment enclosure building integrity is consistent with the current licensing basis for Seabrook (i.e., TS 1.31, TS 3/4.6.5.2, TS 3/4.6.5.3)	DORL: An 8 hour AOT is less onerous than requiring entry into LCO 3.0.3.	SCVB: Repairing or replacing door equipment quickly (within 8 hours) will avoid an un-necessary reactor shutdown and start-up cycle.
DORL: 24 hours to restore containment enclosure building integrity is consistent with the Westinghouse STS (NUREG-1431) Shield Building TS 3.6.8. The TS Bases state that 24 hours is a reasonable completion time (i.e., AOT) considering the limited leakage design of containment and the low probability of a DBA occurring during this time period. Note: it doesn't matter that Seabrook only has one door. The STS Action statement related to the 24 hour completion time is for "Shield building inoperable." For plants with 2 doors, this would mean both doors are inoperable or there is some other structural problem (e.g., hole in the wall). Regardless, the STS allow 24 hours to restore operability.	SCVB: It is both the NRC staff and the licensee's judgment that 8 hours is more than an adequate amount of time to analyze and repair or replace door seals, latches or hinges.	STSB: The most conservative option for a single door access opening design which is less robust than the standard access opening PWR enclosure building design. That is Seabrook TS should not provide operational flexibility when a single failure results in loss of CEB integrity since, neither, preventative or corrective maintenance can be performed on a door without losing CEB integrity, whereas a dual door design would have to have twice as many failures for the condition to be present.

Option 1: 24 hour AOT	Option 2: 8 hour AOT (Corrective Maintenance)	Option 3: Proceed Directly to 3.0.3
DORL: 24 hours to restore containment enclosure building integrity is consistent with TSTF-287, Rev. 5. This TSTF provides a 24 hour AOT for room/boundary degradation (as opposed to ventilation train degradation). This TSTF explains that under existing TSs (i.e., without the TSTF), LCO 3.0.3 must be entered for 2 train inoperability. The TSTF allows 24 hours (during operating modes) to restore the capability to maintain proper pressure before requiring the unit to perform an orderly shutdown. The TSTF states that requiring a plant to enter LCO 3.0.3 when the ventilation envelope is not intact is excessive. The TSTF justifies the change by based on the low probability of a DBA occurring during the 24 hour AOT. The TSTF also states it is modeled on the NUREG-1431 Shield Building STS.	STSB: Establishes a reasonable remedial action for a single door design when compared to STS if the Condition is written so the 8 hour AOT applies for the door inoperable due to preventative or corrective maintenance. Additional observations: (1) This action could be viewed as a relaxation of the STS 24 hour repair AOT for an STS dual entry door design because the CEB is operable with one door closed. So the 24 hour AOT is applied only for repair when both doors are not closed or when another a loss of CEB function exists. With an 8 hour corrective maintenance AOT, compared to a STS plant, Seabrook will accumulate more hours of safety system unavailability due to corrective maintenance activities. In my opinion this makes a case for applying 8 hours for corrective maintenance and LCO 3.0.3 for repair or CEB integrity otherwise not met.	AADB: None.
SCVB: Accommodates license's request.	AADB: Appropriately limits the amount of time of non-compliance with the design-basis accident analysis for activities more likely to occur while allowing adequate time to fix a problem.	
STSB: Establishes consistency with STS Shield Building integrity AOT.	AADB: Allows adequate time to fix more likely to occur problems with doors without cycling the plant into a risky shutdown evolution.	

Option 1: 24 hour AOT	Option 2: 8 hour AOT (Corrective Maintenance)	Option 3: Proceed Directly to 3.0.3
STSB: STSB disagrees with DORL's comments. When the CEB is opened for other than normal entry/exit, LCO 3.6.5.1 defaults to a LCO 3.0.3 shutdown (due to both ventilation trains being considered inoperable due to the potential failure of the drawdown time surveillance requirement).	AADB: Is appropriately more restrictive than the STS Shield Building TS due to the unique Seabrook CEB design with a single door as the barrier to the release of fission products.	
AADB: Supports resolution of an inspection finding in a manner that is consistent with the current licensing basis for the Seabrook CEB and prior staff position established for the equivalent Shield Building by the STS.		
AADB: Provides a reasonable time to restore a design barrier that functions to mitigate the consequences of an accident, does not function to prevent an accident from occurring, and is not one of the three primary barriers in the protection of the public from release of fission products.		

II. ***Cons of Options Associated with Failure of the Door*** ***i.e.,*** *a loss of Function Condition in TS 3.6.5.2 for one access opening door inoperable for other than preventative maintenance or for planned equipment ingress or egress.*

Option 1: 24 hour AOT	**Option 2: 8 hour AOT (Corrective Maintenance)**	**Option 3: Proceed Directly to 3.0.3**
SCVB: The requested 24 hour AOT is an increase in risk. It is an un-analyzed condition. It is without compensatory measurers. It is not reasonable engineering judgment. It is an un-necessary request based on the history of the plant and therefore should not be allowed.	DORL: Inconsistent with the current licensing basis.	DORL: Inconsistent with the current licensing basis.
STSB: The safety basis for this AOT is questionable for a single door design.	DORL: Not what the licensee requested or agreed to during the current amendment review.	DORL: Requiring a plant shutdown when you don't have containment enclosure building integrity is excessive given the low probability of a DBA occurring during the 24 hour period.
STSB: It equates the AOT for failure of the single CEB access opening door to simultaneous failure of two doors for the STS Shield Building dual access opening door design.	SCVB: The 8 hour AOT is based on engineering judgment rather than a quantitative analysis.	DORL: Maintaining the plant at power reduces the risk of a transient that could occur during a plant shutdown.
STSB: Relaxes the current CEB because a door failure starts a 24 hour clock for CEB integrity and also results in LCO 3.0.3 entry due to drawdown times not met for both CEEACSs.	STSB: If written as a separate condition from the 8 hour AOT for preventative maintenance, then TS would permit CEB integrity to be inoperable continuously for up to 16 hours.	DORL: The regulatory basis to require plant shutdown when in this LCO Action statement has not been adequately articulated. There is no basis for requiring a licensee to meet dose acceptance criteria while in an LCO Action statement.
AADB: During the 24 hours in which the Seabrook CEB is inoperable, a potential release pathway for unfiltered fission products could exist in the unlikely event of a design basis LOCA occurring during the period. AADB: The 24 hour completion time allows a longer period of non-compliance with the design-basis accident analysis than other options.	DORL: The licensee has only agreed to an 8 hour AOT for preventive maintenance. If the licensee does not agree to this, the NRC staff will have to write a denial SE and offer the licensee hearing rights.	DORL: A specific safety concern related to requiring a plant shutdown when in this LCO Action statement has not been adequately articulated.

Option 1: 24 hour AOT	Option 2: 8 hour AOT (Corrective Maintenance)	Option 3: Proceed Directly to 3.0.3
	AADB: Not consistent with the STS.	SCVB: A door that cannot be repaired in 8 hours will likely have a more significant problem than a defective door seal or a door latch.
		DORL: The licensee has not agreed to delete the 24 hour AOT CEB integrity tech spec. If the licensee agrees to this, the NRC will have to re-issue the *Federal Register* notice (30-day comment period & 60-day hearing period). If the licensee does not agree to this, the NRC staff will have to write a denial SE and offer the licensee hearing rights.
		AADB: Excessive action for a design barrier that is not one of the three primary barriers of protection from fission product release that increases the risk of a plant transient.
		AADB: Creates excessive focus on regulatory compliance issues without creating compensating increase in safe operation of the plant.

Buford, Angela

From: Marshall, Michael
Sent: Saturday, October 13, 2012 11:21 AM
To: Buford, Angela
Subject: FW: Evaluation of FP-100716

Hello Angie,

I misplaced your email listed below. Please, resend it to me along with the email that is referred to in your email below. If you no longer have the emails, just send me the attachment. Thanks.

Michael

From: Cook, William
Sent: Tuesday, October 02, 2012 4:37 PM
To: Buford, Angela
Cc: Marshall, Michael; Conte, Richard; Raymond, William
Subject: RE: Evaluation of FP-100716

Angie,
I read thru it, good engineering insights and analysis. I still need to think how best to leverage/incorporate it into the report. I'm confident we'll get there.
Thanks again,
Bill

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Bill,

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Also - I touch on it briefly in the attached comments, but there is more to come on the adequacy of crack mapping/visual examination for characterizing and monitoring progression of ASR. I'm working on a technical position paper on that subject.

Thanks,

Angie

RB46

Cc: Conte, Richard; Raymond, William
Subject: Evaluation of FP-100716

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Thanks,

Angie

Marshall, Michael

From: Raymond, William
Sent: Sunday, October 14, 2012 3:13 PM
To: Conte, Richard; Marshall, Michael; Murphy, Martin; Khanna, Meena; Lamb, John; Morey, Dennis; Milano, Patrick; Buford, Angela; Thomas, George; Sheikh, Abdul
Cc: Cook, William; Trapp, James; Miller, Chris; Wilson, Peter; Burritt, Arthur; Chaudhary, Suresh
Subject: RE: POD for Pri. Cont. FW: Upload to CERTREC

Rich et. al.,
Note that the document is not an OD per EN-AA-203-1001 and contains a bounding analysis (similar to that in the Interim Assessment) for two of 4 cases evaluated.
The tech eval does not address operability or "full qualification per the CLB", but concludes the containment has structural integrity per ASME III, Div 2 and is "fully capable of all of its design basis functions". Despite the nuances on procedures/processes, based on my initial review I think the evaluation makes the case that containment integrity is intact and there is no immediate safety concern. I welcome discussion by others on the NRC staff.

I reviewed ASR technical evaluation for containment and have access to the references (drawings and calculations) quoted in the document.
I am working with NextEra to validate assumptions used regarding reinforcement details (drawing) and stresses (calcs).
I will report on my results on Monday.
Bill

From: Conte, Richard
Sent: Sunday, October 14, 2012 12:39 PM
To: Marshall, Michael; Murphy, Martin; Khanna, Meena; Lamb, John; Morey, Dennis; Milano, Patrick; Raymond, William; Buford, Angela; Thomas, George; Sheikh, Abdul
Cc: Cook, William; Trapp, James; Miller, Chris; Wilson, Peter; Burritt, Arthur; Chaudhary, Suresh
Subject: POD for Pri. Cont. FW: Upload to CERTREC

Just want to confirm that Angie is representing DE and DLR and she will consult with George and Abdul as necessary.

Q&A for licensee on the document will be sometime Wednesday morning October 17.

From: Willoughby, Paul [mailto:Paul.Willoughby@nexteraenergy.com]
Sent: Saturday, October 13, 2012 1:11 AM
To: Conte, Richard; Cook, William; Raymond, William
Cc: Vassallo, Theodore; Brown, Brian; Noble, Rick; OKeefe, Michael
Subject: Upload to CERTREC

Impact of ASR on Seabrook Station Containment Structure (AR1804477) has been uploaded to CERTREC.

B19

Buford, Angela

From: Buford, Angela
Sent: Monday, October 15, 2012 8:01 AM
To: Marshall, Michael
Subject: RE: Evaluation of FP-100716

Hi Michael,

I also sent the region an evaluation of the finite element analysis of the containment enclosure building. Do you want me to send you that as well?

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8,50

Thanks,

Angie

Buford, Angela

From: Marshall, Michael
Sent: Monday, October 15, 2012 8:29 PM
To: Buford, Angela
Subject: RE: RESPONSE TO YOUR REQUEST: FW: Evaluation of FP-100716

Angie,

Sorry, I asked for the wrong thing. I wanted your review of the licensee's use of finite element analysis. Could you please, send me that inspection input.

Michael

From: Buford, Angela
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To: Marshall, Michael
Subject: RESPONSE TO YOUR REQUEST: FW: Evaluation of FP-100716

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Thanks,

Angie

B5

Buford, Angela

From: Marshall, Michael
Sent: Monday, October 15, 2012 8:52 AM
To: Buford, Angela
Subject: RE: Evaluation of FP-100716

Angie,

Yes.

Thank You.

Michael

From: Buford, Angela
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Subject: RE: Evaluation of FP-100716

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From: Buford, Angela
Sent: Tuesday, October 02, 2012 3:37 PM
To: Cook, William

Buford, Angela

From: Buford, Angela
Sent: Monday, October 15, 2012 11:30 PM
To: Marshall, Michael
Subject: RE: RESPONSE TO YOUR REQUEST: FW: Evaluation of FP-100716
Attachments: Comments on FEA referenced in FP100716 - Buford.docx

Attached.

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B52

Buford, Angela

From: Buford, Angela
Sent: Monday, October 15, 2012 10:42 AM
To: Marshall, Michael
Subject: RESPONSE TO YOUR REQUEST: FW: Evaluation of FP-100716
Attachments: Notes on FP 100716 Rev.docx

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Cc: Conte, Richard; Raymond, William
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Thanks,

Angie

Comments on Finite Element Analysis model referenced in FP 100716, "Impact of ASR on Concrete Structures and Attachments", Section 5: Evaluation of Structural Demand and Seismic Response

Opinion Ratings:

Acceptable

Acceptable for now

Not readily acceptable – Technical Justification Needed

Unacceptable

Review Topics

Bounding Analysis: **Acceptable for now**

- FP100700 (SGH 110594-01) provides the licensee's effort to categorize the CEB wall into representative zones based on a walkdown of the structure and Cracking Index measurements. Questionable to this as the bounding analysis in terms of operability of other structures because this document states that "CI values and number of cracks at each CI location on the CEB wall are much lower than those at other structures at Seabrook Station where we made measurements..." The licensee admits that the CEB is mild in terms of ASR presence on site. In my opinion, it's not appropriate to use this calculation alone to bound the structural response to dynamic load for all of the rest of the structures on site.
- Also note that CEB HAS shear reinforcement whereas the worst structure, the "B" electrical tunnel, does not have shear reinforcement.
- Acceptable for now because ASR problem is not severe, even in most severe areas

Applying Visual Analysis Results to CEB structure: **Acceptable for now**

- FP100715 (SGH 11594-04)Figures A4-A7 show ASR Mapping results on FEM
  - Note – unknown regions of the CEB were assigned Rating #1 (least affected by ASR). That is nonconservative and cannot continue to be acceptable in future finite element models. For now it might be okay considering the nearby "known" regions are also a Rating #1. But we see from Figure A-7, there are rating #5 (worst case ASR) elements right next to rating #1 elements. Which means you can't assume unknown regions will be assigned to rating #1.
  - Note that there is a distinct elevation line separating the existence of ASR from ASR-free concrete. Need to check if that is the true case in the field (i.e., ASR "begins" at the same elevation in the structure or if this is an assumption that there is a generally "acceptable" ASR cutoff point in the structure for this finite element model.

- Correlation is established based on visual rating of ASR distress, and CI values could not be used to supplement the visual ratings because the lack of published correlations between CI and changes in properties. How can a visual observation correlate but a quantifiable measurement like CI can't? Assuming a Modulus of Elasticity value from visual observation cannot contain less uncertainty than from a quantifiable data point. Especially since they plan to characterize ASR in the future using crack mapping data.

Approach of using Backfit Model, then Undamaged and then Damaged Models: **Acceptable**

- The purpose of the backfit model is to more accurately compute the forces/moments in the structure and supercedes the original United Engineers forces. Backfit FEM models openings in the structure and variations in thickness, whereas the original UE calculation did not. Forces obtained from the backfit model were used to determine seismic response values in the other two models. Static analysis was done to calculate structure response to nonseismic and static equivalent load conditions. This approach to modeling is overall acceptable.

Structural Capacity Maintained with ASR: **Acceptable for now**

- FP100715 (SCH 110594-04) Part 5.2 (page 17 of 72), Unverified assumptions, states "structural capacities to be unaffected by ASR for this study and are calculated per ACI 318-71...Additional testing or research is needed to quantify the effect of ASR damage on concrete section capacity." The licensee assumes the concrete (both affected and unaffected) maintain the original design compressive strength capacity of f'c = 4000 ksi. The final calculation compares ASR affected concrete to its capacity – it is unconservative to assume there has been no reduction in this value, especially when there has not been a conclusion made that can rule out reduction in compressive strength. In addition, some structures on site were designed to 3000, not 4000 psi.

Approach of using Backfit Model, then Undamaged and then Damaged Models: **Acceptable**

- The purpose of the backfit model is to more accurately compute the forces/moments in the structure and supercedes the original United Engineers forces. Backfit FEM models openings in the structure and variations in thickness, whereas the original UE calculation did not. Forces obtained from the backfit model were used to determine seismic response values in the other two models. This approach to modeling is overall acceptable.

Use of Modulus of Elasticity Values to Characterize ASR and Poisson's Ratio Issue: **Acceptable for now**

- This approach is acceptable, but the data used to estimate moduli of elasticity is not reliable. Values obtained from visual walkdown of other structures not based on actual CEB. Cores obtained elsewhere, from other areas. FP100696 Section 3: Licensee states the current approach is limited by small number of removed samples and even smaller number of CEB samples.

- FP 100696 Section 5.1 – Justified Assumptions: material properties of the ASR-affected concrete can be conservatively represented by the results of testing of near-surface cores. If so, why are the near surface core testing results being discounted in other areas of the licensee's explanation and analysis?
- FP 100696 Section 5.2 – Unverified assumptions: limited and varied number of samples. Licensee says modeling is ultimately used for comparative study only, so that doesn't matter. It does matter, however, because in later models, f'c capacity was said to be 4000 for all concrete. And we know that that value may be lower. Disagree that this is a truly comparative study, enough to have an understanding of the effect of ASR. Need more data.
- Poisson's ratio: ratio of lateral expansion to longitudinal shortening: if different for ASR-affected concrete vs non-ASR-affected concrete, why wouldn't it change between levels of ASR degradation? We would want to see a technical justification for not varying the poisson's ratio in the ASR-affected concrete

Boundary Conditions: **Not readily acceptable – Technical Justification Needed**

- In FP100715 it states that the undamaged and ASR-damaged models are radially fixed at El. 0 (ground level) and below, citing the concrete backfill enabling the structure to be completely fixed. I don't agree that it can be assumed the concrete backfill would not transfer any load to the CEB structure, and there is no technical basis to assert that ground motion would not cause the earthquake load on the backfill concrete to affect the CEB structure. I do not agree that the model should show the structure being radially fixed from ground level down to -30. For the purposes of this static/dynamic model, the model should be fixed only where there is an integral fixed connection transferring the load to bedrock. This approach may not be appropriate, and it may or may not have a significant effect on the outcome of the model.

Mistake in Model? Or just in Report: **Acceptable for now**

- Appendix B, Section B-2 Design Inputs has an apparent discrepancy with regards to Appendix A. Static earth pressure section states that the static earth pressure was applied from El. 0 to El. 20. But their numbering convention has El. 0 being at ground level and going down to -30.
- Same problem with Appendix D, Section D-2 for dynamic earth pressure loads

Approach for Dispositioning Overstress Conditions FP100715 Section H: **Not readily acceptable – Technical Justification Needed**

- Finite element model results show areas of localized overstress (i.e., when they ran the model, some areas showed that the concrete was stressed beyond its design limits). Licensee, if they could not correct the overstress problem for a localized area, expanded the area in question to a length 4 times the wall thickness for vertical section cuts, and distance opening to opening for

horizontal section cuts and averaged stresses over the expanded area to reduce the amount of localized stress. There is no technical basis for this. While structural engineers will sometimes consider a 10% overstress passable, it is on a case-by-case basis, and not a wholescale approach of expanding the section size to 4x wall thickness or from opening to opening. I don't think this is appropriate. The licensee would have to justify why this is a conservative approach.

- Section H4 - Overstresses near corners of an opening - agree that typically there is additional reinforcement and higher stress concentrations, but you must calculate allowable stress in that corner, and use the actual additional reinforcement strength added? Typically this is taken care of by corner bars and extra reinforcing, however, it should be checked every time. In this analysis, the licensee dispositioned overstresses at openings without further technical review. It may be acceptable to have these overstresses, but they must provide technical basis.
- Section H-6 states that the overstress can, in part, be dispositioned to the fact that the design concrete strength of 4000 psi is used in design evaluations which might be conservative as limited number of core samples showed that the actual concrete strength may be higher even at damaged areas. Do not agree with this, although this entire disposition parts 1, 2 and 3 is acceptable.
- Model shows failure for out-of-plane moment axial force interaction for the large opening on the west side, for both the undamaged and ASR-damaged cases (it appears, even with their two methodologies to disposition areas of apparent overstress). The licensee is making these assumptions about additional diagonal reinforcement and the thickened wall section will allow for redistribution that would account for the overstress. There is no calculation to support this assertion, and there is just as good of a chance that the calculation will not repair the overstress condition. Licensee has bad practice, generally, of assuming that things will work out and not actually performing calculations. See Table H-5

Comments on Finite Element Analysis model referenced in FP 100716, "Impact of ASR on Concrete Structures and Attachments", Section 5: Evaluation of Structural Demand and Seismic Response

Opinion Ratings:

Acceptable

Acceptable for now

Not readily acceptable – Technical Justification Needed

Unacceptable

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- The purpose of the backfit model is to more accurately compute the forces/moments in the structure and supercedes the original United Engineers forces. Backfit FEM models openings in the structure and variations in thickness, whereas the original UE calculation did not. Forces obtained from the backfit model were used to determine seismic response values in the other two models. Static analysis was done to calculate structure response to nonseismic and static equivalent load conditions. This approach to modeling is overall acceptable.

Structural Capacity Maintained with ASR: **Acceptable for now**

- FP100715 (SCH 110594-04) Part 5.2 (page 17 of 72), Unverified assumptions, states "structural capacities to be unaffected by ASR for this study and are calculated per ACI 318-71...Additional testing or research is needed to quantify the effect of ASR damage on concrete section capacity." The licensee assumes the concrete (both affected and unaffected) maintain the original design compressive strength capacity of f'c = 4000 ksi. The final calculation compares ASR affected concrete to its capacity – it is unconservative to assume there has been no reduction in this value, especially when there has not been a conclusion made that can rule out reduction in compressive strength. In addition, some structures on site were designed to 3000, not 4000 psi.

Approach of using Backfit Model, then Undamaged and then Damaged Models: **Acceptable**

- The purpose of the backfit model is to more accurately compute the forces/moments in the structure and supercedes the original United Engineers forces. Backfit FEM models openings in the structure and variations in thickness, whereas the original UE calculation did not. Forces obtained from the backfit model were used to determine seismic response values in the other two models. This approach to modeling is overall acceptable.

Use of Modulus of Elasticity Values to Characterize ASR and Poisson's Ratio Issue: **Acceptable for now**

- This approach is acceptable, but the data used to estimate moduli of elasticity is not reliable. Values obtained from visual walkdown of other structures not based on actual CEB. Cores obtained elsewhere, from other areas. FP100696 Section 3: Licensee states the current approach is limited by small number of removed samples and even smaller number of CEB samples.

- FP 100696 Section 5.1 – Justified Assumptions: material properties of the ASR-affected concrete can be conservatively represented by the results of testing of near-surface cores. If so, why are the near surface core testing results being discounted in other areas of the licensee's explanation and analysis?
- FP 100696 Section 5.2 – Unverified assumptions: limited and varied number of samples. Licensee says modeling is ultimately used for comparative study only, so that doesn't matter. It does matter, however, because in later models, f'c capacity was said to be 4000 for all concrete. And we know that that value may be lower. Disagree that this is a truly comparative study, enough to have an understanding of the effect of ASR. Need more data.
- Poisson's ratio: ratio of lateral expansion to longitudinal shortening: if different for ASR-affected concrete vs non-ASR-affected concrete, why wouldn't it change between levels of ASR degradation? We would want to see a technical justification for not varying the poisson's ratio in the ASR-affected concrete

Boundary Conditions: **Not readily acceptable – Technical Justification Needed**

- In FP100715 it states that the undamaged and ASR-damaged models are radially fixed at El. 0 (ground level) and below, citing the concrete backfill enabling the structure to be completely fixed. I don't agree that it can be assumed the concrete backfill would not transfer any load to the CEB structure, and there is no technical basis to assert that ground motion would not cause the earthquake load on the backfill concrete to affect the CEB structure. I do not agree that the model should show the structure being radially fixed from ground level down to -30. For the purposes of this static/dynamic model, the model should be fixed only where there is an integral fixed connection transferring the load to bedrock. This approach may not be appropriate, and it may or may not have a significant effect on the outcome of the model.

Mistake in Model? Or just in Report: **Acceptable for now**

- Appendix B, Section B-2 Design Inputs has an apparent discrepancy with regards to Appendix A. Static earth pressure section states that the static earth pressure was applied from El. 0 to El. 20. But their numbering convention has El. 0 being at ground level and going down to -30.
- Same problem with Appendix D, Section D-2 for dynamic earth pressure loads

Approach for Dispositioning Overstress Conditions FP100715 Section H: **Not readily acceptable – Technical Justification Needed**

- Finite element model results show areas of localized overstress (i.e., when they ran the model, some areas showed that the concrete was stressed beyond its design limits). Licensee, if they could not correct the overstress problem for a localized area, expanded the area in question to a length 4 times the wall thickness for vertical section cuts, and distance opening to opening for

horizontal section cuts and averaged stresses over the expanded area to reduce the amount of localized stress. There is no technical basis for this. While structural engineers will sometimes consider a 10% overstress passable, it is on a case-by-case basis, and not a wholescale approach of expanding the section size to 4x wall thickness or from opening to opening. I don't think this is appropriate. The licensee would have to justify why this is a conservative approach.

- Section H4 - Overstresses near corners of an opening - agree that typically there is additional reinforcement and higher stress concentrations, but you must calculate allowable stress in that corner, and use the actual additional reinforcement strength added? Typically this is taken care of by corner bars and extra reinforcing, however, it should be checked every time. In this analysis, the licensee dispositioned overstresses at openings without further technical review. It may be acceptable to have these overstresses, but they must provide technical basis.
- Section H-6 states that the overstress can, in part, be dispositioned to the fact that the design concrete strength of 4000 psi is used in design evaluations which might be conservative as limited number of core samples showed that the actual concrete strength may be higher even at damaged areas. Do not agree with this, although this entire disposition parts 1, 2 and 3 is acceptable.
- Model shows failure for out-of-plane moment axial force interaction for the large opening on the west side, for both the undamaged and ASR-damaged cases (it appears, even with their two methodologies to disposition areas of apparent overstress). The licensee is making these assumptions about additional diagonal reinforcement and the thickened wall section will allow for redistribution that would account for the overstress. There is no calculation to support this assertion, and there is just as good of a chance that the calculation will not repair the overstress condition. Licensee has bad practice, generally, of assuming that things will work out and not actually performing calculations. See Table H-5

Notes on FP 100716

- Shear Capacity/Margin: The licensee states that ACI 318-71 includes 50% margin on shear capacity for components up to two feet thick. This is not valid, as ACI 318-71 assumes concrete has not been affected by ASR. The licensee cannot assume that the relationships in the design code are still valid. However, the research has shown that 25% decrease in shear capacity is a conservative estimate, given the relatively mild level of current ASR degradation at Seabrook.

- Lap Splice Strength: There are 47 evaluations that show concrete to have "insufficient margin to accommodate ASR" based on a 40% reduction in lap splice strength, but the licensee states that the use of a 40% reduction is not appropriate. They cite, qualitatively, reasons why 40% should not be used: The licensee stated that the pullout test method is "outdated" and "known to be unrealistic". If there is much relevant information that shows the pullout test is unrealistic, the licensee should have a way to quantify the error of using the pullout test method and apply the error in order to obtain a "usable" value. Also, licensee stated "The test used reinforcing steel much smaller than typical reinforcing steel used at Seabrook Station. Reinforcement anchorage is known as a limit state that does not scale well". Need information to back up that statement. The design of lap splices is based on area of steel that is in contact with the concrete and the bond between concrete and steel (which is reduced with ASR, as the concrete often tends to crack along the length of the rebar). The assertion that reinforcing bar size does not scale well to lap splice strength needs adequate technical justification. The evaluation states that the testing used to obtain this data was targeted to advanced levels of ASR degradation. There is no information to demonstrate the level of ASR distress in the specimens used in the test, but it is agreed that Seabrook ASR is not far advanced, so maybe the rationale is okay for this interim assessment.

- Anchor bolt testing – licensee performed testing on anchor bolts post installed into concrete girders at Ferguson lab. While the testing provides some insights into the behavior of anchors at Seabrook, the data is incomplete as it used anchors that were installed into concrete that was already affected by ASR, while the anchors at Seabrook were already installed when the ASR started. The reduction in capacity was 16% for the anchors tested as part of this program. Given some margin in the design, we can live with this for now. It would not be suitable for a long-term operability determination because the ASR mechanism occurring after anchors were installed into the originally ASR-free concrete means that the anchors have potentially "loosened" during the reaction, whereas post-installed anchors drilled into the concrete for testing purposes here would potentially perform better because they can achieve a tighter "grip" into the concrete and thus have a higher pullout strength.

- Section 3.1.1, Petrographic Examination – the licensee stated that it performed petrographic examinations on sections of three 16" cores from the interior face of the B Electrical Tunnel wall. Licensee did petrographic analysis of the cores and noted that

there was a higher degree of ASR cracking in the samples near the exposed interior wall surfaces. The licensee was not able to say definitively that there is only ASR occurring outside of the rebar cage. Either way, this note should be minimized in our determination of the suitability of this engineering evaluation because there have been instances where the relative humidity inside the concrete causes ASR to occur (sometimes to a distressed state) while the outside concrete is not affected. The point is that this may be a case where the licensee has a favorable data point (i.e., one set of three cores taken from the same location of one affected structure that appears to show that ASR is minimal inside the rebar cage) but no grounds besides that to assert that ASR is only really prevalent in cover concrete (which is what they are implying). The licensee often states this in discussions on ASR and it might be worth highlighting that we have no basis by which to agree with this. Along the same line, it may be worth highlighting that the licensee has implied through this demonstration (and research also shows) that visual indications alone may not be the most effective way to measure ASR degradation and that for the current program and long term operation, it will be necessary to have petrographic analysis (i.e., more core samples) of important structures to verify the extent of ASR degradation as opposed to solely relying upon visual examination that has the potential to give specious results.

- Mechanical Testing of Concrete Cores –

    - Cores applicability to Concrete Strength: Research shows that concrete strengths obtained from the original cylinders that were prepared on site should not be used as the original in situ concrete strength. According to research, "core tests [in general, not specific to ASR] cannot be translated to terms of standard cylinder strength with any degree of confidence", meaning that concrete cylinders that were prepared when the concrete was poured usually show a higher 28-day strength value than what really exists in situ. The cylinders are only used as a measure to demonstrate that concrete has attained sufficient strength to remove forms, or to show that the concrete is not significantly below its design strength. This thought yields two consequences:
        - 1. It may not be valuable to attribute 28-day cylinder testing results to the "original design strength" of the concrete and apply it to make a determination of how much concrete strength has been "lost" since it was poured.
        - 2. Core tests can, however, give us an idea of the concrete strength, but the data must be applied in one of two ways: Either (1) compare ASR-affected concrete strengths with concrete strengths of non-ASR-affected areas of the same structure, applying the same methodology for identification of ASR, to see the relative difference in strength attributed to the ASR; or (2) apply a method of using multiplying factors that take into account the inherent differences between in-situ concrete and core samples (as shown in Canadian research)

- Additional core sampling – (Ref Section 3.1.2, Mechanical Testing of Cores) Additional core sampling is not planned yet by the licensee. The licensee has taken the position that mechanical testing will tell them nothing about the structural performance in-situ. However, the concrete is designed to maintain some material properties and is relied upon to work integrally with the steel to maintain structural capability. The main properties to be understood are compressive strength, tensile strength, and modulus of elasticity. While ASR effects can potentially vary for different areas, the comparison of ASR affected concrete to non-ASR affected concrete is of interest. A Canadian research effort was undertaken to provide guidance on how to relate the strength of cores to the in situ strength of concrete, including factors (multipliers) to account for various attributes of cores, e.g. microcracking caused by drilling, length-to-width ratio, moisture condition, etc. It seems that, for each building of concern (at least the safety-related or important to safety buildings), cores taken from both ASR affected areas and non-ASR affected areas can be compared to give an "apples to apples" baseline for the effect of ASR degradation for each structure compared to itself and way to compare future ASR damage. This would also give data other than surface visual indications, which may or may not accurately characterize the ASR damage. Later on, there would be a way to compare strength properties as ASR progresses, to get a better understanding of how the concrete itself is degrading. Core testing would also look for delamination of the concrete along the plane of the rebar, which cannot be indicated by visual examination.

- Structural Walkdown (Section 3.2) – No issues. Agree with licensee's methodologies presented here to determine the presence of ASR and give a preliminary qualitative measure of surface cracking. As discussed in the above bullet, more should be done in significant structures to achieve a quantitative baseline (cores, petrographic analysis of the extent of ASR degradation, strength testing, so that future data can be compared with original data)

- Effect of confinement on ASR Expansion (Section 4.1.3) – Any increase in flexural strength properties due to ASR result from the expansive stresses on the rebar causing a prestressing phenomenon where stresses in the concrete are transferred to the steel. The reinforcing steel wants to retract from the expansive stresses (in the elastic range of the steel). While this phenomenon can temporarily increase the behavior of reinforced concrete beams in flexure, the added stress on the rebar is of concern, since, unlike a prestressed concrete element, these structures were not designed for this. For structures with a small percentage of reinforcement and large expansions, the stress in the steel will be large. It is not appropriate to credit any benefit to structural behavior, especially since the licensee does not plan on inserting strain gauges to measure rebar strain and ensure that stress remains below the design strength of the rebar given other loads.

Thomas, George

From: Thomas, George
Sent: Tuesday, October 16, 2012 9:26 PM
To: Murphy, Martin
Subject: RE: For Your Review - C-10 Response Letter - Seabrook ASR
Attachments: Response Letter to C-10 letter on ASR at Seabrook - Rev 5 - NRR Comments gt1.doc

Marty,
For your review, I have marked-up (using track changes) my suggested changes/additions/edits in the attached file. If you are OK, please forward to John Lamb.
Thanks.
George

From: Murphy, Martin
Sent: Monday, October 15, 2012 2:23 PM
To: Thomas, George
Subject: FW: For Your Review - C-10 Response Letter - Seabrook ASR
Importance: High

For review, should be the same as what I just sent to you

From: Lamb, John
Sent: Monday, October 15, 2012 1:06 PM
To: Murphy, Martin; Marshall, Michael
Cc: Ennis, Rick; Khanna, Meena; Conte, Richard
Subject: For Your Review - C-10 Response Letter - Seabrook ASR
Importance: High

Marty & Michael,

Attached, for your review, is the NRC response letter to the C-10 Seabrook ASR concerns. Attached are DORL minor editorial comments. Please provide your technical/editorial comments by **noon on Wednesday, October 17, 2012**.

If I have not heard from you by 12:01 pm on Wednesday, October 17, 2012, I will assume that you are OK with the existing letter and you do not have any comments.

Thanks.
John

RJ

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION I
2100 RENAISSANCE BOULEVARD, SUITE 100
KING OF PRUSSIA, PENNSYLVANIA 19406-2713

Ms. Debbie Grinnell
C-10 Foundation
44 Merrimac Street
Newburyport, MA 01950

Mr. David Wright
Union of Concerned Scientists
Two Brattle Square, #600
Cambridge, MA 02128

Dear Ms. Grinnell and Mr. Wright:

I am responding to the comments that you provided the U.S. Nuclear Regulatory Commission (NRC) staff at the public meeting on April 23, 2012 (Agencywide Documents and Access Management System (ADAMS Accession No. ML121160459), as supplemented by email dated April 24, 2012 (ADAMS Accession No. ML121160451). In your comments and email, you detailed your organizations' concerns regarding the concrete degradation noted at the Seabrook Station due to alkali-silica reaction (ASR), and asked a range of questions regarding how this issue is being addressed by the NRC.

Also your organizations have provided an additional letter September 13, 2012, in which you requested that we require NextEra to begin a complete structural integrity evaluation during the current refueling outage. After speaking with you and receiving an email of September 28, 2012, we understand that both C-10 and UCS do not want us to consider the September 13, 2012, letter a 10 CFR 2.206 petition but you would like to keep your options open after ~~hearing~~ receiving a response from us. We understand that the purpose of your request is determine the status and extent of the ~~Alkali-Silica Reaction (~~ASR degradation present in the containment building, and any accompanying corrosion to the containment liner plate or other steel structures, including embedded concrete reinforcement steel). Our preliminary response is noted below but we will send you a more detailed response at a later time shortly after we issue our first inspection report on the matter related to the follow-up inspections on certain items of the Confirmatory Action Letter, which is expected to be issued in November 2012.

Evaluations of extent of conditions at the site had already begun. During the NextEra contractor walk down, some indications were identified in three areas on the exterior wall of primary containment that indicated the potential for ASR affecting those areas. Those areas were the bases for NextEra's report to the Advisory Committee on Reactor Safety on July 10, 2012 (ADAMS Accession No. ML122070401), that primary containment was potentially affected by ASR. During this outage, NextEra will be conducting an operability determination and taking data for ultrasonic readings of the primary containment inner wall liner on the backside of one of the three areas that is potentially affected by ASR. We will document our review of this matter in the above noted report to be issued in November 2012. We are satisfied with NextEra's

actions to date with respect to primary containment since operability determination has elements of an engineering evaluation required by our regulations.

We will take into account any new information provided in your most recent letter. We believe that we have sufficiently communicated our status of review and view on operability in this letter and in periodic telephone conversations with Ms. Grinnell of the C10 organization. Your organizations' interest in this matter is shared by other stakeholders as well. We intend to keep the public informed of our inspection efforts and any related findings on this matter.

In your letter and email of April 2012, you requested answers to several questions. Our response to those questions is enclosed. If we can be of additional assistance, please contact Richard Conte of my staff at 610-337-5183 or Richard.Conte@nrc.gov.

Sincerely,

Christopher G. Miller, Director
Division of Reactor Safety
Region I

Enclosure:
As stated

Docket No. 50-443

cc: Distribution via Listserv

We will take into account any new information provided in your most recent letter. We believe that we have sufficiently communicated our status of review and view on operability in this letter and in periodic telephone conversations with Ms. Grinnell of the C10 organization. Your organizations' interest in this matter is shared by other stakeholders as well. We intend to keep the public informed of our inspection efforts and any related findings on this matter.

In your letter and email of April 2012, you requested answers to several questions. Our response to those questions is enclosed. If we can be of additional assistance, please contact Richard Conte of my staff at 610-337-5183 or Richard.Conte@nrc.gov.

Sincerely,

Christopher G. Miller, Director
Division of Reactor Safety
Region I

Enclosure:
As stated

Docket No. 50-443

cc: Distribution via Listserv

ADAMS Accession No: ML12170B043 ***via email**

OFFICE	DRS/BC	DRS/BC	DRP/BC	NRR/DORL	DRS/BC	
NAME	RConte	JTrapp	ABurrit	MKhanna	CMiller	
DATE	06 /20/12	06/25 /12	/ /12	/ /12	/ /12	/ /12

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NUCLEAR REGULATORY COMMISSION RESPONSE TO QUESTIONS

POSED BY C-10 AND UNION OF CONCERNED SCIENTISTS

ON CONCRETE DEGRADATION BY ALKALI-SILICA REACTION

At the U.S. Nuclear Regulatory Commission (NRC) public meeting held on April 23, 2012, regarding concrete degradation by alkali-silica reaction (ASR) at Seabrook Station, Unit 1 (Seabrook), Ms. Debbie Grinnell of C-10 Foundation (C-10) provided the NRC staff with comments and questions (Agencywide Documents and Access Management System (ADAMS Accession No. ML121160459) written by C-10 and Union of Concerned Scientists (UCS).

Ms. Debbie Grinnell of C-10 provided the NRC staff an email dated April 24, 2012 (ADAMS Accession No. ML12116451) with a substitute list of documents to be requested of NextEra.

NRC Staff Background Information:

On March 26, 2012 (ADAMS Accession No. ML120480066), the NRC issued an inspection report for Seabrook (No. 05000443/2011010) related to the ASR issue in safety-related structures. As noted in the inspection report, NRC expert review determined the ASR-affected structures remained capable of performing their safety-related functions. This determination was based in part by the following: (1) conservative safety load factors associated with dominant loads in controlling load conditions and engineering conservatisms in design provide reasonable expectations that affected structures can perform their safety function, despite the current licensing and design bases design margin being reduced by the change of mechanical properties; (2) field walk-downs confirmed no visible indication of significant deformation, distortion, or displacement of structures, or rebar corrosion; (3) ASR-identified was limited to localized areas in the concrete walls; and (4) progression of ASR degradation is occurring slowly based on existing operating experience and NextEra Energy Seabrook, LLC (NextEra) continues to monitor the affected structures.

At the meeting, the NRC staff reviewed the comments from C-10 and UCS provided on April 23, 2012 and listened to comments from the C-10 representative at the meeting. We have also reviewed the C-10 email dated April 24, 2012. The NRC staff thanked C-10 and UCS for providing information as to what C-10 and UCS believes should be obtained from NextEra; however, the NRC staff has since issued a confirmatory action letter (CAL) to NextEra regarding the concrete degradation issues related to ASR. A CAL is an administrative mechanism to confirm a licensee's voluntary agreement to take certain actions.

The conclusion of the licensee's assessment is that, given the current extent of ASR cracking, the affected reinforced concrete structures at Seabrook remain suitable for continued service for at least an interim period. This conclusion is based on the following considerations:

(1) ASR ~~has a negligible~~ effect on the structural demand and seismic response of the affected reinforced concrete structures at Seabrook was found to be not significant.

(2) Although there may have been some reduction in structural capacity, the reduction is less than that necessary to challenge the suitability of the structures for operation during an interim period.

(3) Results from a comprehensive walkdown effort show that the extent of ASR cracking in the great majority of areas in the plant is sufficiently low and that published guidance indicates that detailed evaluations are not necessary in such cases.

(4) For the areas that had sufficient cracking to merit a detailed evaluation, the great majority either have positive margin or sufficient margin that can likely be recovered to accommodate potential effects of ASR degradation.

Given the conservatism in the evaluation methodology and the fact that the available test data on effects of ASR on reinforced concrete components are for small-scale tests that are not representative of a large structure, NextEra concluded that there was reasonable assurance that structures are suitable for continued service.

By letter dated May 16, 2012 (ADAMS Accession No. ML12125A172), the NRC issued a CAL to NextEra regarding the concrete degradation issues related to ASR. The below list of pertinent documents related to the CAL or recent ASR developments in this area are the documents we asked to be submitted or have completed and subject to inspection review. Many of the documents listed in the C-10 and UCS letter later revised by email of April 24, 2012 are documents that are normally kept on site and subject to inspections. Onsite documents reviewed in the current inspection report will be listed in the "documents reviewed" section of our report. Some of the references below are used in the response to your questions. Accordingly the documents requested by NRC staff are only those as addressed in the above noted CAL and are summarized below.

CAL Related List of References and ML Nos.

NRC Documents:

1. Region I – NRR Task Interface Agreement, issued September 12, 2012 (ADAMS Accession No. ML111610530, not publicly available)

2. NRC Inspection Report No. 0500433/2011010 issued March 26, 2012 (ADAMS Accession No. ML120480066)

3. Management Meeting of April 23, 2010, Meeting Notice (ADAMS Accession Nos. ML1132360175)

4. Management Meeting of April 23, 2010, NRC Questions/Slides/Summary(ADAMS Accession Nos. ML121040102/ML121160333, ML121160433, ML121220109)

5. Confirmatory Action Letter No. 2012-002, dated May 16, 2012 (ADAMS Accession No. ML12125A172)

6. Transcript of Advisory Committee on Reactor Safety (ACRS) Plant License Renewal Subcommittee Meeting of July 10, 2012, issued July 25, 2012 (ADAMS Accession No. ML122070401)

7. NRC Staff Alkali-Silica Reaction (ASR) Working Group Charter, issued July 9, 2012 (ADAMS Accession No. ML121250588, publicly available September 14, 2012)

8. NRC Staff Memorandum, issued September 5, 2012, on Request for Deviation from the Reactor Oversight Process Action Matrix to Provide Increased Oversight of the Alkali-Silica Reaction Issue at Seabrook (ADAMS Accession No. ML12242A372)

9. Letter to NextEra, issued September 12, 2012, Transmitting the Memorandum Related to the Deviation from the Reactor Oversight Process Action Matrix for Seabrook Station No. 1 (ADAMS Accession No. ML12242A363 (ADAMS Package))

Licensee Documents (Publicly Available):

10. Management Meeting of April 23, 2010, NextEra/Consultant Slides (ADAMS Accession Nos. ML121160349, ML121160414, and ML121160422)

11. NextEra in letters dated May 3, and May 10, 2012 (ADAMS Accession Nos. ML12125A022 and ML12131A479)

12. NextEra Letter of May 24, 2012, Ltr & Encl. For CAL Item 5, Submit the root cause for the organizational causes associated with the occurrence of ASR at Seabrook Station and related corrective actions by May 25, 2012 (ADAMs Accession No. ML12151A396).

13. NextEra Letter of May 24, 2012, Encl 2 For CAL Item 6, Submit the evaluation, "Impact of ASR on Concrete Structures and Attachments," (Foreign Print 100716) by May 25, 2012 (ADAMs Accession No. ML12151A397)

14. NextEra Letter of June 8, 2012, For CAL Item 7, Submit the corrective action plan for the continued assessment of ASR in concrete structures at Seabrook Station including development of remedial actions to mitigate the affects of ASR, where warranted, by June 8, 2012 (ADAMS Accession No. ML12171A277)

15. NextEra Letter of June 21, 2012, for CAL Item 8, Submit the technical details of the testing planned at the contracted research and development facility by June 30, 2012 (ADAMS Accession No. ML12179A281 and ML12179A282).

C-10 and UCS Question 1

1. Is ASR inherent to the concrete used at Seabrook and induced merely by exposure to water regardless of its source, or is ASR induced by chemicals in the ground water? If it is inherent, how widespread is this problem throughout the concrete in the plant?

NRC Staff Response 1

~~The ASR is inherent to the concrete in which silicon or sand from the aggregate (course rocks in the concrete mix) becomes reactive in the presence of high ph water in the concrete and combines with alkali such as potassium or sodium from the cement paste to form a gel. The gel absorbs water and expansion starts within the concrete manifesting itself on path of least resistance leading to the inside wall of concrete.~~

ASR is a slow chemical process that could occur over time in hardened concrete. The reaction requires reactive forms of silica (from aggregate in concrete), alkali content (sodium and potassium hydroxides) in cement , and adequate moisture regardless of source (exposure to ground water ingress, highly humid conditions, precipitation, etc.) to form a gel. The ASR gel expands by absorbing water causing a network of microcracks along paths of least resistance. The typical ASR map or pattern cracking is more pronounced at the surface because of least confinement or constraint from reinforcement. The reaction occurs only when all the three ingredients for the reaction mentioned above are present. ASR reaction is not induced by chemicals in ground water.

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ASR is inherent in the concrete used at Seabrook since a slow reactive aggregate, that met the ASTM standards at the time for assessing potential aggregate reactivity, was unknowingly used in the concrete mix. The affected below-grade structures were exposed to ground water intrusion.

In the summer of 2011 and after receiving the laboratory test and examination reports, Seabrook confirmed concrete degradation by ASR in selected areas of several safety-related structures. This discovery by the licensee was unexpected since it was believed that the concrete constituents used at Seabrook would not normally be expected to be susceptible to ASR at the time of construction since: (1) the coarse aggregate is largely igneous rock that was routinely tested during construction and passed petrographic examinations and expansive reaction tests that normally detect ASR; and (2) low-alkali portland cement was abundantly used. The extent of conditions found is addressed in the next question.

The licensee reported that, after subsequent years that the Seabrook concrete was in place, the associated standards were updated to caution that the tests specified may not accurately predict reactive aggregates when dealing with late/slow ~~expanding reactive~~ reacting aggregates containing strained quartz or microcrystalline quartz, such as the coarse aggregates used at Seabrook. It was also learned by the licensee that the concrete industry, in conjunction with the American Society of Testing Material, developed new, more ~~accurate and~~ reliable test methods to assess potentially reactive coarse aggregates. Other causes were noted. A summary of NextEra's root cause evaluation is publicly available (reference No. 12).

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 2

2. What, quantitatively, is the extent to which ASR is occurring, both with respect to locations throughout the plant and with respect to the position within the thickness of the concrete walls themselves?

NRC Staff Response 2

ASR was first confirmed in the "B" electric tunnel in August 2010 by NextEra. Since this area exhibited the most visible degradation, it has received the most extensive inspection, testing and review. As NextEra expanded their review, the licensee confirmed ASR impacting additional buildings based on core sampling and conducting tests for compressive strength and modulus of elasticity in the containment enclosure building, residual heat removal vault, emergency diesel generator building, emergency feedwater pump house, primary auxiliary building, main steam/feedwater pipe chase East, alternate cooling tower, and service water pump house. A summary of NextEra's extent of condition and interim structural assessment is publicly available (reference No. 13).

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 3

3. What basis is there for predicting whether or not ASR has occurred or will occur at locations not yet identified?

NRC Staff Response 3

Visual symptoms that could be indicative of potentially ASR-affected areas are map or pattern cracking, surface discoloration and staining, gel exudations and white surface deposits, occasional popouts, etc. However, ~~The~~ the only way to positively confirm that ASR has occurred is by petrographic examination. Petrographic examination is the process by which samples of concrete cores are examined under a microscope for microcracking and other physical properties. NextEra at the Management Meeting of April 23, 2012, discussed a visual criteria for ASR. It is the staff's understanding that the criteria is being used to conservatively assume ASR had affected a building and the building has been placed into the monitoring program; the visual criteria cannot be used to clear exclude a building of being effected by ASR.

Reference 12 reported that the applicable ASTM standard has been revised to address the detection of late- or slow-expanding reactive aggregates containing strained quartz or microcrystalline quartz such as the course aggregates used at Seabrook. It was also learned that the concrete industry in conjunction with ASTM developed new, more accurate and reliable test methods to assess potentially reactive course aggregates.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 4

4. Is the ASR accompanied by other deleterious reactions, especially corrosion of embedded steel and sulfate attack, and how severe and widespread are those effects throughout the plant's structure?

NRC Staff Response 4

Confinement by reinforcement and other external sources is a key factor regarding the impact of ASR on reinforced concrete structures.
Confinement limits ASR expansion of the *in situ* structure, which reduces the extent of deleterious cracking and the resultant reduction in concrete properties. Given this interplay between an expansive ASR degradation and structural restraint, the licensee's long term testing is focused on the evaluation of the structural impacts due to ASR in the concrete integrated with the rebar system.

No corrosion is anticipated from the gel formed by ASR because of alkaline concrete conditions. Given that the groundwater continues to permeate through certain concrete wall and the groudwater is termed "aggressive", the licensee will need to provide a basis for no significant rebar corrosion. To date, there is no evidence of rebar corrosion as it would surely be seen on the interior walls of the affected buildings through rust stains. The licensee's structures monitoring program provides areas for which groundwater infiltration is most pronounced for additional monitoring periodically.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Questions 5

5. What basis is there for predicting the rate of corrosion of the steel reinforcement in the concrete that is currently exposed to infiltrating ground water, or that is likely to be exposed in the future? What effect will the corrosion have on the structure at Seabrook?

NRC Staff Response 5

Given the high ph pH environment of the reinforcement steel in concrete, no corrosion is anticipated. However that needs to be confirmed by sampling inspection in light of the groundwater being termed "aggressive." The licensee has done some inspection in this area and found no evidence of corrosion. Also, if corrosion was occurring, it would be evident by rust staining and corrosion products on the surface of the concrete. Both the licensee and NRC inspectors have confirmed no such staining in the areas that are most pronounced in groundwater infiltration. The issue as to whether or not more invasive inspection is needed is currently being reviewed.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Questions 6

6. What, quantitatively, is the extent to which ASR has reduced mechanical properties of the concrete compared to control samples of concrete obtained from non-damaged locations? What effect will the damaged areas have on the structure?

NRC Staff Responses 6

The current follow-up inspection will address the reductions in compressive strength and modulus of elasticity (see reference 13 – Chapter 3 section 3.1.2 for values reported by NextEra). This data is based on a limited number of core samples. The licensee has conducted additional testing for compressive strength on the control building areas and has found that none of the results exceed the design value; and, on average, the results are well above the design value (3,000 psi). While acceptable from a design viewpoint, there is sufficient information to say that the conditions are degraded and thus the need for the operability determinations that will remain open pending the results of larger scale testing. After further review of technical information and expert consultation, NextEra changed its approach to identify the areas impacted by ASR and then to perform structural assessments through the evaluation of available margins to offset assumed lower-bound reductions, from literature, in structural capacity (reference 13). The licensee has also undertaken a research project involving larger-scale testing to address structural performance of ASR-affected components (in the structural context of reinforced concrete as opposed to material property context) for limit states where gaps exist in the ASR literature.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 7

7. What basis is there for predicting the future loss in important mechanical properties of concrete, such as compressive and splitting tensile strengths, at locations where ASR has been identified?

NRC Staff Response 7

The licensee is implementing periodic crack indexing of selected affected areas to monitor and trend the progression of ASR cracking. The issue of adequate baseline information and need for additional monitoring periodically is currently being reviewed. The results of the unrestrained core testing by NextEra and their bounding calculations were documented in a letter dated May 24, 2012, (reference 13) and it provides the basis for their conclusion of operability but degraded.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 8

8. What basis is there for predicting the plant's ability to maintain structural integrity and safety-related functions in a seismic event given the extent of the ASR damage and steel corrosion in plant structures?

NRC Staff Response 8

The licensee is implementing an action plan that includes literature reviews, extensive walkdowns, limited core testing, crack indexing, large-scale testing, structural assessments and evaluations, etc to comprehensively address, monitor and manage the the ASR issue at the site and to provide reasonable assurance that the affected structures remain capable of performing their safety functions through its service life. The issue of adequate baseline information and need for additional monitoring periodically and/or other actions is currently being reviewed. The results of the unrestrained core testing by the licensee and their bounding calculations were documented in references 13 and it provides the basis for their conclusion of operability but degraded.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 9

9. What mitigation/remediation strategies are available and what is the basis for establishing the probability of success of those strategies?

NRC Staff Response 9

Pending the NextEra acquiring adequate baseline information, adequate longer term monitoring techniques, and results of larger scale testing, there may not be a need for mitigation/remediation strategies. However the licensee has a contingency as a part of the larger scale testing program to evaluate mitigation/remediation strategies on extra specimens being produced for the larger scale testing. Reference 15 provided a summary of the scope of the testing planned at the licensee's research and development facility.

Should mitigation/remediation strategies become necessary, we will evaluate them on a case-by-case bases.

From: Erickson, Alice
To: Buford, Angela
Subject: RE: Evaluation of FP-100716
Date: Tuesday, October 16, 2012 7:07:00 AM
Attachments: Notes on FP 100716 Rev- AE Comments.docx

Angie,

I considered your comments, only in terms of our license renewal review and our current position, and have two comments for you to consider. Please let me know if you have any questions!

Alice

From: Buford, Angela
Sent: Thursday, October 11, 2012 9:24 AM
To: Erickson, Alice
Subject: FW: Evaluation of FP-100716

Alice,

Can you look at these comments and let me know if you believe something may not jive with DLR staff's position or understanding in terms of the LR review. As we discussed, if you can respond by early next week, I'd appreciate it!

Thanks,

Angie

From: Buford, Angela
Sent: Friday, October 05, 2012 9:55 AM
To: Thomas, George
Cc: Cook, William
Subject: FW: Evaluation of FP-100716

George,

Attached are the comments I sent Bill Cook on FP 100716, the Seabrook Interim Structural Evaluation. Can you please review and advise on whether you think something is off the mark or in your opinion mischaracterized.

I think Bill is going to touch base with you at some point in the near future as well.

Thanks,

Angie

From: Buford, Angela
Sent: Tuesday, October 02, 2012 3:37 PM

B54

To: Cook, William
Cc: Conte, Richard; Raymond, William
Subject: Evaluation of FP-100716

Bill,

Attached are my comments on the structural evaluation, FP 100716 Seabrook response to CAL. Previously I sent you specific comments on the Finite Element Analysis performed as the Bounding Evaluation for the Containment Enclosure Building specifically. The comments on/evaluation of the FEA model for the CEB I sent previously should act as a supplement to this document.

Also - I touch on it briefly in the attached comments, but there is more to come on the adequacy of crack mapping/visual examination for characterizing and monitoring progression of ASR. I'm working on a technical position paper on that subject.

Thanks,

Angie

Notes on FP 100716

- Shear Capacity/Margin: The licensee states that ACI 318-71 includes 50% margin on shear capacity for components up to two feet thick. This is not valid, as ACI 318-71 assumes concrete has not been affected by ASR. The licensee cannot assume that the relationships in the design code are still valid. However, the research has shown that 25% decrease in shear capacity is a conservative estimate, given the relatively mild level of current ASR degradation at Seabrook.

- Lap Splice Strength: There are 47 evaluations that show concrete to have "insufficient margin to accommodate ASR" based on a 40% reduction in lap splice strength, but the licensee states that the use of a 40% reduction is not appropriate. They cite, qualitatively, reasons why 40% should not be used: The licensee stated that the pullout test method is "outdated" and "known to be unrealistic". If there is much relevant information that shows the pullout test is unrealistic, the licensee should have a way to quantify the error of using the pullout test method and apply the error in order to obtain a "usable" value. Also, licensee stated "The test used reinforcing steel much smaller than typical reinforcing steel used at Seabrook Station. Reinforcement anchorage is known as a limit state that does not scale well". Need information to back up that statement. The design of lap splices is based on area of steel that is in contact with the concrete and the bond between concrete and steel (which is reduced with ASR, as the concrete often tends to crack along the length of the rebar). The assertion that reinforcing bar size does not scale well to lap splice strength needs adequate technical justification. The evaluation states that the testing used to obtain this data was targeted to advanced levels of ASR degradation. There is no information to demonstrate the level of ASR distress in the specimens used in the test, but it is agreed that Seabrook ASR is not far advanced, so maybe the rationale is okay for this interim assessment.

- Anchor bolt testing – licensee performed testing on anchor bolts post installed into concrete girders at Ferguson lab. While the testing provides some insights into the behavior of anchors at Seabrook, the data is incomplete as it used anchors that were installed into concrete that was already affected by ASR, while the anchors at Seabrook were already installed when the ASR started. The reduction in capacity was 16% for the anchors tested as part of this program. Given some margin in the design, we can live with this for now. It would not be suitable for a long-term operability determination because the ASR mechanism occurring after anchors were installed into the originally ASR-free concrete means that the anchors have potentially "loosened" during the reaction, whereas post-installed anchors drilled into the concrete for testing purposes here would potentially perform better because they can achieve a tighter "grip" into the concrete and thus have a higher pullout strength.

- Section 3.1.1, Petrographic Examination – the licensee stated that it performed petrographic examinations on sections of three 16" cores from the interior face of the B Electrical Tunnel wall. Licensee did petrographic analysis of the cores and noted that

Comment [A1]: Is it possible to delete this sentence and simply highlight the differences of the conditions (i.e. anchor bolts installed prior to vs. after concrete being affected by ASR)?

Another view would be that the reduction in anchor capacity, for anchor bolts installed after the concrete has been affected by ASR , would be greater than what currently exists at Seabrook because when you install the anchor bolts into already weakened concrete, the additional torque may further reduce the anchor capacity.

DLR currently has issued an RAI related to concrete anchor capacity. Making this statement before we receive our response may limit our acceptance of the response.

there was a higher degree of ASR cracking in the samples near the exposed interior wall surfaces. The licensee was not able to say definitively that there is only ASR occurring outside of the rebar cage. Either way, this note should be minimized in our determination of the suitability of this engineering evaluation because there have been instances where the relative humidity inside the concrete causes ASR to occur (sometimes to a distressed state) while the outside concrete is not affected. The point is that this may be a case where the licensee has a favorable data point (i.e., one set of three cores taken from the same location of one affected structure that appears to show that ASR is minimal inside the rebar cage) but no grounds besides that to assert that ASR is only really prevalent in cover concrete (which is what they are implying). The licensee often states this in discussions on ASR and it might be worth highlighting that we have no basis by which to agree with this. Along the same line, it may be worth highlighting that the licensee has implied through this demonstration (and research also shows) that visual indications alone may not be the most effective way to measure ASR degradation and that for the current program and long term operation, it will be necessary to have petrographic analysis (i.e., more core samples) of important structures to verify the extent of ASR degradation as opposed to solely relying upon visual examination that has the potential to give specious results.

Comment [A2]: Are you implying they should be taking cores in areas where there are no indications of ASR? To what extent?

DLRs view is that they can conservatively consider an area to be affected by ASR based on visual examinations, assuming we agree with their acceptance criteria, but they cannot confirm the absence of ASR through visual examinations. Further testing would be needed to confirm the absence of ASR.

- Mechanical Testing of Concrete Cores –
    - Cores applicability to Concrete Strength: Research shows that concrete strengths obtained from the original cylinders that were prepared on site should not be used as the original in situ concrete strength. According to research, "core tests [in general, not specific to ASR] cannot be translated to terms of standard cylinder strength with any degree of confidence", meaning that concrete cylinders that were prepared when the concrete was poured usually show a higher 28-day strength value than what really exists in situ. The cylinders are only used as a measure to demonstrate that concrete has attained sufficient strength to remove forms, or to show that the concrete is not significantly below its design strength. This thought yields two consequences:
        - 1. It may not be valuable to attribute 28-day cylinder testing results to the "original design strength" of the concrete and apply it to make a determination of how much concrete strength has been "lost" since it was poured.
        - 2. Core tests can, however, give us an idea of the concrete strength, but the data must be applied in one of two ways: Either (1) compare ASR-affected concrete strengths with concrete strengths of non-ASR-affected areas of the same structure, applying the same methodology for identification of ASR, to see the relative difference in strength attributed to the ASR; or (2) apply a method of using multiplying factors that take into account the inherent differences between in-situ concrete and core samples (as shown in Canadian research)

- Additional core sampling – (Ref Section 3.1.2, Mechanical Testing of Cores) Additional core sampling is not planned yet by the licensee. The licensee has taken the position that mechanical testing will tell them nothing about the structural performance in-situ. However, the concrete is designed to maintain some material properties and is relied upon to work integrally with the steel to maintain structural capability. The main properties to be understood are compressive strength, tensile strength, and modulus of elasticity. While ASR effects can potentially vary for different areas, the comparison of ASR affected concrete to non-ASR affected concrete is of interest. A Canadian research effort was undertaken to provide guidance on how to relate the strength of cores to the in situ strength of concrete, including factors (multipliers) to account for various attributes of cores, e.g. microcracking caused by drilling, length-to-width ratio, moisture condition, etc. It seems that, for each building of concern (at least the safety-related or important to safety buildings), cores taken from both ASR affected areas and non-ASR affected areas can be compared to give an "apples to apples" baseline for the effect of ASR degradation for each structure compared to itself and way to compare future ASR damage. This would also give data other than surface visual indications, which may or may not accurately characterize the ASR damage. Later on, there would be a way to compare strength properties as ASR progresses, to get a better understanding of how the concrete itself is degrading. Core testing would also look for delamination of the concrete along the plane of the rebar, which cannot be indicated by visual examination.

- Structural Walkdown (Section 3.2) – No issues. Agree with licensee's methodologies presented here to determine the presence of ASR and give a preliminary qualitative measure of surface cracking. As discussed in the above bullet, more should be done in significant structures to achieve a quantitative baseline (cores, petrographic analysis of the extent of ASR degradation, strength testing, so that future data can be compared with original data)

- Effect of confinement on ASR Expansion (Section 4.1.3) – Any increase in flexural strength properties due to ASR result from the expansive stresses on the rebar causing a prestressing phenomenon where stresses in the concrete are transferred to the steel. The reinforcing steel wants to retract from the expansive stresses (in the elastic range of the steel). While this phenomenon can temporarily increase the behavior of reinforced concrete beams in flexure, the added stress on the rebar is of concern, since, unlike a prestressed concrete element, these structures were not designed for this. For structures with a small percentage of reinforcement and large expansions, the stress in the steel will be large. It is not appropriate to credit any benefit to structural behavior, especially since the licensee does not plan on inserting strain gauges to measure rebar strain and ensure that stress remains below the design strength of the rebar given other loads.

Buford, Angela

From: Buford, Angela
Sent: Wednesday, October 17, 2012 12:58 PM
To: Marshall, Michael
Subject: RE: REQUEST: Resp to C10 Quest - Seabrook ASR

Michael, No problem - I'll prioritize this for now over the Seabrook Containment work.

-----Original Message-----
From: Marshall, Michael
Sent: Wednesday, October 17, 2012 12:54 PM
To: Buford, Angela
Subject: REQUEST: Resp to C10 Quest - Seabrook ASR
Importance: High

Hello Angie,

Any chance you can read the attached in the next two hours and share your comments with me. Thanks.

Michael L. Marshall, Jr.
Chief
Aging Management of Structures, Electrical, and Systems Branch Division of License Renewal Office of Nuclear Reactor Regulation

301-415-2871
Email: michael.marshall@nrc.gov

-----Original Message-----
From: Lamb, John
Sent: Wednesday, October 17, 2012 11:18 AM
To: Khanna, Meena
Cc: Conte, Richard; Ennis, Rick; Murphy, Martin; Thomas, George; Marshall, Michael; Powell, Raymond
Subject: FYI: Resp to C10 Quest - Seabrook ASR
Importance: High

Meena,

Attached, for your info, are the consolidated comments from DORL and EMCB that I have received to date regarding the C-10/UCS ASR response letter. If I receive any other comments, I will consolidate them into the attached document and forward them to you immediately.

Thanks.
John

-----Original Message-----
From: Khanna, Meena
Sent: Wednesday, October 17, 2012 11:11 AM
To: Conte, Richard
Cc: Lamb, John
Subject: Resp to C10 Quest

B55

Rich, could you pls email me your fax no. so that I can fax you my comments as I am out of the office. I will provide concurrence for NRR today, thx

Buford, Angela

From: Buford, Angela
Sent: Wednesday, October 17, 2012 3:57 PM
To: Marshall, Michael
Subject: RESPONSE: RE: REQUEST: Resp to C10 Quest - Seabrook ASR
Attachments: Response Letter to C-10 letter on ASR at Seabrook - Rev 5 - NRR Comments DORL EMCB DLR.docx

Michael,

Attached find my comments on the C-10 letter. My comments, deletions and additions are in RED and my comments are identified with my initials.

-----Original Message-----
From: Marshall, Michael
Sent: Wednesday, October 17, 2012 12:54 PM
To: Buford, Angela
Subject: REQUEST: Resp to C10 Quest - Seabrook ASR
Importance: High

Hello Angie,

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Michael L. Marshall, Jr.
Chief
Aging Management of Structures, Electrical, and Systems Branch Division of License Renewal Office of Nuclear Reactor Regulation

301-415-2871
Email: michael.marshall@nrc.gov

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Sent: Wednesday, October 17, 2012 11:18 AM
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Thanks.
John

-----Original Message-----
From: Khanna, Meena

B5b

Sent: Wednesday, October 17, 2012 11:11 AM
To: Conte, Richard
Cc: Lamb, John
Subject: Resp to C10 Quest

Rich, could you pls email me your fax no. so that I can fax you my comments as I am out of the office. I will provide concurrence for NRR today, thx

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION I
2100 RENAISSANCE BOULEVARD, SUITE 100
KING OF PRUSSIA, PENNSYLVANIA 19406-2713

Ms. Debbie Grinnell
C-10 Foundation
44 Merrimac Street
Newburyport, MA 01950

Mr. David Wright
Union of Concerned Scientists
Two Brattle Square, #600
Cambridge, MA 02128

Dear Ms. Grinnell and Mr. Wright:

I am responding to the comments that you provided the U.S. Nuclear Regulatory Commission (NRC) staff at the public meeting on April 23, 2012 (Agencywide Documents and Access Management System (ADAMS Accession No. ML121160459), as supplemented by email dated April 24, 2012 (ADAMS Accession No. ML121160451). In your comments and email, you detailed your organizations' concerns regarding the concrete degradation noted at the Seabrook Station due to alkali-silica reaction (ASR), and asked a range of questions regarding how this issue is being addressed by the NRC.

Also your organizations have provided an additional letter September 13, 2012, in which you requested that we require NextEra to begin a complete structural integrity evaluation during the current refueling outage. After speaking with you and receiving an email of September 28, 2012, we understand that both C-10 and UCS do not want us to consider the September 13, 2012, letter a 10 CFR 2.206 petition but you would like to keep your options open after ~~hearing~~ receiving a response from us. We understand that the purpose of your request is to determine the status and extent of the Alkali-Silica Reaction (ASR) degradation present in the containment building, and any accompanying corrosion to the containment liner plate or other steel structures, including embedded reinforcing steel~~)~~. Our preliminary response is noted below but we will send you a more detailed response at a later time shortly after we issue our first inspection report on the matter related to the follow-up inspections on certain items of the Confirmatory Action Letter, which is expected to be issued in November, 2012.

Evaluations of extent of conditions at the site had already begun. During the NextEra contractor walk down, three areas on the exterior wall of primary containment had indications that had the potential to be ASR. Those areas were the bases for NextEra's report to the Advisory Committee on Reactor Safety on July 10, 2012 (ADAMS Accession No. ML122070401), that primary containment was potentially affected by ASR. During this outage, NextEra will be conducting an operability determination and taking data for ultrasonic readings of the primary containment inner wall liner on the backside of one of the three areas that is potentially affected by ASR. We will document our review of this matter in the above noted report to be issued in November 2012. We are satisfied with NextEra's actions to date with respect to primary

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Comment [A1]: Needs context or different wording related to the rest of the sentence (AB)

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Comment [A2]: Licensee did not do OD. They performed a structural evaluation of containment per Tier 3 criteria of Structures Monitoring Program (AB)

containment since operability determination has elements of an engineering evaluation required by our regulations.

Comment [A3]: Consider re-wording away from referring to OD (AB)

We will take into account any new information provided in your most recent letter. We believe that we have sufficiently communicated our status of review and view on operability in this letter and in periodic telephone conversations with Ms. Grinnell of the C10 organization. Your organizations' interest in this matter is shared by other stakeholders as well. We intend to keep the public informed of our inspection efforts and any related findings on this matter.

In your letter and email of April 2012, you requested answers to several questions. Our response to those questions is enclosed. If we can be of additional assistance, please contact Richard Conte of my staff at 610-337-5183 or Richard.Conte@nrc.gov.

Sincerely,

Christopher G. Miller, Director
Division of Reactor Safety
Region I

Enclosure:
As stated

Docket No. 50-443

cc: Distribution via Listserv

We will take into account any new information provided in your most recent letter. We believe that we have sufficiently communicated our status of review and view on operability in this letter and in periodic telephone conversations with Ms. Grinnell of the C10 organization. Your organizations' interest in this matter is shared by other stakeholders as well. We intend to keep the public informed of our inspection efforts and any related findings on this matter.

In your letter and email of April 2012, you requested answers to several questions. Our response to those questions is enclosed. If we can be of additional assistance, please contact Richard Conte of my staff at 610-337-5183 or Richard.Conte@nrc.gov.

Sincerely,

Christopher G. Miller, Director
Division of Reactor Safety
Region I

Enclosure:
As stated

Docket No. 50-443

cc: Distribution via Listserv

ADAMS Accession No: ML12170B043 ***via email**

OFFICE	DRS/BC	DRS/BC	DRP/BC	NRR/DORL	DRS/BC	
NAME	RConte	JTrapp	ABurrit	MKhanna	CMiller	
DATE	06 /20/12	06/25 /12	/ /12	/ /12	/ /12	/ /12

OFFICIAL RECORD COPY

NUCLEAR REGULATORY COMMISSION RESPONSE TO QUESTIONS

POSED BY C-10 AND UNION OF CONCERNED SCIENTISTS

ON CONCRETE DEGRADATION BY ALKALI-SILICA REACTION

At the U.S. Nuclear Regulatory Commission (NRC) public meeting held on April 23, 2012, regarding concrete degradation by alkali-silica reaction (ASR) at Seabrook Station, Unit 1 (Seabrook), Ms. Debbie Grinnell of C-10 Foundation (C-10) provided the NRC staff with comments and questions (Agencywide Documents and Access Management System (ADAMS Accession No. ML121160459) written by C-10 and Union of Concerned Scientists (UCS).

Ms. Debbie Grinnell of C-10 provided the NRC staff an email dated April 24, 2012 (ADAMS Accession No. ML12116451) with a substitute list of documents to be requested of NextEra.

NRC Staff Background Information:

On March 26, 2012 (ADAMS Accession No. ML120480066), the NRC issued an inspection report for Seabrook (No. 05000443/2011010) related to the ASR issue in safety-related structures. As noted in the inspection report, NRC expert review determined the ASR-affected structures remained capable of performing their safety-related functions. This determination was based in part by the following: (1) conservative safety load factors associated with dominant loads in controlling load conditions and engineering conservatisms in design provide reasonable expectation that affected structures can perform their safety function, despite the current licensing and design bases design margin being reduced by the change of mechanical properties; (2) field walk-downs confirmed no visible indication of significant deformation, distortion, or displacement of structures, or rebar corrosion; (3) the ASR identified was limited to localized areas in the concrete walls; and (4) progression of ASR degradation is occurring slowly based on existing operating experience and NextEra Energy Seabrook, LLC (NextEra) continues to monitor the affected structures.

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At the public meeting, the NRC staff reviewed the comments from C-10 and UCS provided on April 23, 2012 and received comments from the C-10 representative at the meeting. We have also reviewed the C-10 email dated April 24, 2012. The NRC staff thanked C-10 and UCS for providing their opinion as to what information C-10 and UCS believes should be obtained from NextEra; the NRC staff has since issued a confirmatory action letter (CAL) to NextEra regarding the concrete degradation issues related to ASR. A CAL is an administrative mechanism to confirm a licensee's voluntary agreement to take certain actions.

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The conclusion of the licensee's assessment is that, given the current extent of ASR cracking, the affected reinforced concrete structures at Seabrook remain suitable for continued service for at least an interim period. This conclusion is based on the following considerations:

(1) The effects of ASR on the structural demand and seismic response of affected reinforced concrete structures at Seabrook were found not to be significant.

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(2) Although there may have been some reduction in structural capacity, the reduction is less than that necessary to challenge the suitability of the structures for operation during an interim period.

(3) Results from a comprehensive walkdown effort show that the extent of ASR cracking in the great majority of areas in the plant is sufficiently low and published guidance indicates that detailed evaluations are not necessary in such cases.

(4) For the areas that had sufficient cracking to merit a detailed evaluation, the great majority either have positive margin or sufficient margin that can likely be recovered to accommodate potential effects of ASR degradation.

Given the conservatism in the evaluation methodology and the fact that the available test data on effects of ASR on reinforced concrete components are for small-scale tests that are not representative of a large structure, NextEra concluded that there was reasonable assurance that structures are suitable for continued service.

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Comment [A4]: Suggest removing the allusion to the NRC agreeing with the licensee assertion that they have increased margin due to ASR (we have reasons to counter that argument and will likely express such in the inspection report) (AB)

Comment [A5]: Needs a sentence to explain why the NRC was okay with "available test data only being for small-scale tests not representative of a large structure" being a reason to conclude there is reasonable assurance of structural performance. (AB)

By letter dated May 16, 2012 (ADAMS Accession No. ML12125A172), the NRC issued a CAL to NextEra regarding the concrete degradation issues related to ASR. The below list of pertinent documents related to the CAL or recent ASR developments in this area are the documents we asked to be submitted or have completed and subject to inspection review. Many of the documents listed in the C-10 and UCS letter later revised by email of April 24, 2012 are documents that are normally kept on site and subject to inspections. Onsite documents reviewed in the current inspection report will be listed in the "documents reviewed" section of our report. Some of the references below are used in the response to your questions. Accordingly the documents requested by NRC staff are only those as addressed in the above noted CAL and are summarized below.

CAL Related List of References and ML Nos.

NRC Documents:

1. Region I – NRR Task Interface Agreement, issued September 12, 2012 (ADAMS Accession No. ML111610530, not publicly available)

2. NRC Inspection Report No. 0500433/2011010 issued March 26, 2012 (ADAMS Accession No. ML120480066)

3. Management Meeting of April 23, 2010, Meeting Notice (ADAMS Accession Nos. ML1132360175)

4. Management Meeting of April 23, 2010, NRC Questions/Slides/Summary(ADAMS Accession Nos. ML121040102/ML121160333, ML121160433, ML121220109)

5. Confirmatory Action Letter No. 2012-002, dated May 16, 2012 (ADAMS Accession No. ML12125A172)

6. Transcript of Advisory Committee on Reactor Safety (ACRS) Plant License Renewal Subcommittee Meeting of July 10, 2012, issued July 25, 2012 (ADAMS Accession No. ML122070401)

7. NRC Staff Alkali-Silica Reaction (ASR) Working Group Charter, issued July 9, 2012 (ADAMS Accession No. ML121250588, publicly available September 14, 2012)

8. NRC Staff Memorandum, issued September 5, 2012, on Request for Deviation from the Reactor Oversight Process Action Matrix to Provide Increased Oversight of the Alkali-Silica Reaction Issue at Seabrook (ADAMS Accession No. ML12242A372)

9. Letter to NextEra, issued September 12, 2012, Transmitting the Memorandum Related to the Deviation from the Reactor Oversight Process Action Matrix for Seabrook Station No. 1 (ADAMS Accession No. ML12242A363 (ADAMS Package))

Licensee Documents (Publicly Available):

10. Management Meeting of April 23, 2010, NextEra/Consultant Slides (ADAMS Accession Nos. ML121160349, ML121160414, and ML121160422)

11. NextEra in letters dated May 3, and May 10, 2012 (ADAMS Accession Nos. ML12125A022 and ML12131A479)

12. NextEra Letter of May 24, 2012, Ltr & Encl. For CAL Item 5, Submit the root cause for the organizational causes associated with the occurrence of ASR at Seabrook Station and related corrective actions by May 25, 2012 (ADAMs Accession No. ML12151A396).

13. NextEra Letter of May 24, 2012, Encl 2 For CAL Item 6, Submit the evaluation, "Impact of ASR on Concrete Structures and Attachments," (Foreign Print 100716) by May 25, 2012 (ADAMs Accession No. ML12151A397)

14. NextEra Letter of June 8, 2012, For CAL Item 7, Submit the corrective action plan for the continued assessment of ASR in concrete structures at Seabrook Station including development of remedial actions to mitigate the affects of ASR, where warranted, by June 8, 2012 (ADAMS Accession No. ML12171A277)

15. NextEra Letter of June 21, 2012, for CAL Item 8, Submit the technical details of the testing planned at the contracted research and development facility by June 30, 2012 (ADAMS Accession No. ML12179A281 and ML12179A282).

C-10 and UCS Question 1

1. Is ASR inherent to the concrete used at Seabrook and induced merely by exposure to water regardless of its source, or is ASR induced by chemicals in the ground water? If it is inherent, how widespread is this problem throughout the concrete in the plant?

NRC Staff Response 1

ASR is a slow chemical process that could occur over time in hardened concrete. The reaction requires reactive forms of silica (from aggregate in concrete), alkali content (sodium and potassium hydroxides) in cement , and adequate moisture regardless of source (exposure to ground water ingress, highly humid conditions, precipitation, etc.) to form a gel. The ASR gel expands by absorbing water causing a network of microcracks along paths of least resistance. The typical ASR map or pattern cracking is more pronounced at the surface because of least confinement or constraint from reinforcement. The reaction occurs only when all the three ingredients for the reaction mentioned above are present. ASR reaction is not induced by chemicals in ground water.

ASR-potential is inherent in the concrete used at Seabrook since a slow reactive aggregate, was unknowingly used in the concrete mix. The aggregate used met the American Society of Testing Materials (ASTM) standard at that time for assessing the potential and avoiding development of ASR. The affected below-grade structures were exposed to ground water intrusion.

In the summer of 2011 and after receiving the laboratory test and examination reports, Seabrook confirmed concrete degradation by ASR in selected areas of several safety-related structures. This discovery by the licensee was unexpected since it was believed that the concrete constituents used at Seabrook would not normally be expected to be susceptible to ASR at the time of construction since: (1) the coarse aggregate is largely igneous rock that was routinely tested during construction and passed petrographic examinations and expansive reaction tests that normally detect ASR; and (2) low-alkali portland cement was used. The extent of conditions found is addressed in the response to Question 2.

The licensee reported that in subsequent years after the Seabrook concrete was placed, the associated standards were updated to caution that the tests specified may not accurately predict reactivity of aggregates that are late/slow reacting, such as those containing strained quartz or microcrystalline quartz, which were the aggregates used at Seabrook. The licensee also learned that the concrete industry and ASTM developed new, more reliable, test methods to assess potentially reactive coarse aggregates. Other causes were noted. A summary of NextEra's root cause evaluation is publicly available (reference No. 12).

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 2

Deleted: The ASR is inherent to the concrete in which silicon or sand from the aggregate (course rocks in the concrete mix) becomes reactive in the presence of high ph water in the concrete and combines with alkali such as potassium or sodium from the cement paste to form a gel. The gel absorbs water and expansion starts within the concrete manifesting itself on path of least resistance leading to the inside wall of concrete.

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Deleted: that met the ASTM standards at the time for assessing potential aggregate reactivity,

Comment [A6]: Suggest rewording. The tests do not detect ASR, but rather they test for reactivity of the aggregate for ASR potential (AB)

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Comment [A7]: Suggest using a different word than "predict" (AB)

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Deleted: , in conjunction with

Deleted: the American Society of Testing Material,

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2. What, quantitatively, is the extent to which ASR is occurring, both with respect to locations throughout the plant and with respect to the position within the thickness of the concrete walls themselves?

NRC Staff Response 2

ASR was first confirmed in the "B" electric tunnel in August 2010 by NextEra. Since this area exhibited the most visible degradation, it has received the most extensive inspection, testing and review. As NextEra expanded their review, the licensee confirmed ASR impacting additional buildings based on core sampling and conducting tests for compressive strength and modulus of elasticity in the containment enclosure building, residual heat removal vault, emergency diesel generator building, emergency feedwater pump house, primary auxiliary building, main steam/feedwater pipe chase East, alternate cooling tower, and service water pump house. A summary of NextEra's extent of condition and interim structural assessment is publicly available (reference No. 13).

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 3

3. What basis is there for predicting whether or not ASR has occurred or will occur at locations not yet identified?

NRC Staff Response 3

Visual symptoms that could be indicative of potentially ASR-affected areas are map or pattern cracking, surface discoloration and staining, gel exudations and white surface deposits, occasional popouts, etc. However, the only way to positively confirm that ASR has occurred is by petrographic examination. Petrographic examination is the process by which samples of concrete cores are examined under a microscope for microcracking and other physical properties. At a Management Meeting held April 23, 2012, NextEra discussed using visual criteria to detect ASR. It is the staff's understanding that the criteria is being used to conservatively assume ASR is affecting a structure and if it meets the criteria, the structure is placed into the monitoring program. The visual criteria cannot be used to exclude a building of being effected by ASR.

Reference 12 reported that the applicable ASTM standard has been revised to address the detection of late- or slow-expanding reactive aggregates containing strained quartz or microcrystalline quartz such as the course aggregates used at Seabrook. It was also learned that the concrete industry in conjunction with ASTM developed new, more accurate and reliable test methods to assess potentially reactive course aggregates.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 4

Comment [M8]: This response can be read to infer that it 100% of all of these structures are affected. Add words that to some extent address the question and provide some qualitative vice the requested quantitative understanding of the extent, e.g., those areas below grade, a small percentage of the overall surface area ect.

Comment [A9]: Also, possibly provide a ball-park estimate of the percentage of structures in the plant that are affected, or give an idea of the severity observed throughout the plant. (AB)

Comment [M10]: Agree with George's comment, validate could be an alternative as VISUAL EXAMINATION is a recognized and acceptable way of identifying

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Comment [A11]: Suggest adding words to describe what a "Management Meeting" is. For instance "Management Meeting between NRC and NextEra executives"…Or does this refer to the public meeting that continues to be referenced throughout this document? If so I would just say "the April 23rd public meeting" (AB)

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Comment [A12]: Consider stating that the monitoring program being referenced is the licensee's new ASR Monitoring Program (AB)

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Comment [M13]: Affected?

Comment [A14]: I don't think this is true. It's my understanding that once a structure is placed into the ASR monitoring program, it cannot be removed from the program unless a petrographic analysis confirms no ASR. The licensee DOES use the visual criteria to exclude buildings from the ASR Monitoring Program.

Also, to answer the question better, consider stating that as part of the Structures Monitoring Program, all structures of significance are visually examined and that one of the criteria in the examination is presence of ASR, so t… [1]

4. Is the ASR accompanied by other deleterious reactions, especially corrosion of embedded steel and sulfate attack, and how severe and widespread are those effects throughout the plant's structure?

NRC Staff Response 4

Confinement by reinforcement and other external sources is a key factor regarding the impact of ASR on reinforced concrete structures.
Confinement limits ASR expansion of the *in situ* structure, which reduces the extent of deleterious cracking and the resultant reduction in concrete properties. Given this interplay between an expansive ASR degradation and structural restraint, the licensee's long term testing is focused on the evaluation of the structural impacts due to ASR in the concrete integrated with the rebar system.

No corrosion is anticipated from the gel formed by ASR because of alkaline concrete conditions. Given that the groundwater continues to permeate through certain concrete wall and the groudwater is termed "aggressive", the licensee will need to provide a basis for no significant rebar corrosion. To date, there is no evidence of rebar corrosion as it would surely be seen on the interior walls of the affected buildings through rust stains. The licensee's structures monitoring program provides areas for which groundwater infiltration is most pronounced for additional monitoring periodically.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Questions 5

5. What basis is there for predicting the rate of corrosion of the steel reinforcement in the concrete that is currently exposed to infiltrating ground water, or that is likely to be exposed in the future? What effect will the corrosion have on the structure at Seabrook?

NRC Staff Response 5

Given the high pH environment of the reinforcement steel in concrete, no corrosion is anticipated. However that needs to be confirmed by sampling inspection in light of the groundwater being termed "aggressive." The licensee has done some inspection in this area and found no evidence of corrosion. Also, if corrosion was occurring, it would be evident by rust staining and corrosion products on the surface of the concrete. Both the licensee and NRC inspectors have confirmed no such staining in the areas that are most pronounced in groundwater infiltration. The issue as to whether or not more invasive inspection is needed is currently being reviewed.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Questions 6

Comment [A15]: Suggest removing the rebar confinement discussion from this response. Suggest starting with the fact that the licensee has visually inspected the rebar of extracted sections and found no indications of corrosion and then continuing to say that those deleterious reactions can occur to some extent in concrete regardless of whether ASR is present, and that the structures monitoring program addresses those issues and would have criteria for corrective action if needed (AB)

Comment [M16]: What does this statement have to do with the question

Comment [A17]: Consider adding that the licensee has also performed destructive examination to visually inspect rebar in ASR-affected concrete? (AB)

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Comment [M18]: Why not simply state NO CORROSION IS ANTICIPATED – see item 4

6. What, quantitatively, is the extent to which ASR has reduced mechanical properties of the concrete compared to control samples of concrete obtained from non-damaged locations? What effect will the damaged areas have on the structure?

NRC Staff Responses 6

The current follow-up inspection will address the reductions in compressive strength and modulus of elasticity (see reference 13 – Chapter 3 section 3.1.2 for values reported by NextEra). This data is based on a core samples taken by the licensee to date. The licensee has conducted additional testing for compressive strength on the control building areas and has found that none of the results exceed the design value; and, on average, the results are well above the design value (3,000 psi). While acceptable from a design viewpoint, the current data should be supplemented to provide a more extensive understanding of the condition and thus the operability determinations will remain open pending the results of larger scale testing. After further review of technical information and expert consultation, NextEra changed its approach to identify the areas impacted by ASR and then to perform structural assessments through the evaluation of available margins to offset assumed lower-bound reductions, from literature, in structural capacity (reference 13). The licensee has also undertaken a research project involving larger-scale testing to address structural performance of ASR-affected components (in the structural context of reinforced concrete as opposed to material property context) for limit states where gaps exist in the ASR literature.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 7

7. What basis is there for predicting the future loss in important mechanical properties of concrete, such as compressive and splitting tensile strengths, at locations where ASR has been identified?

NRC Staff Response 7

The licensee is implementing periodic crack indexing of selected affected areas to monitor and trend the progression of ASR cracking. The issue of adequate baseline information and need for additional periodic monitoring is currently being reviewed. The results of the unrestrained core testing by NextEra and bounding calculations were documented in a letter dated May 24, 2012, (reference 13); this informationprovides the basis for NextEra's conclusion of operability but degraded.

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 8

8. What basis is there for predicting the plant's ability to maintain structural integrity and safety-related functions in a seismic event given the extent of the ASR damage and steel corrosion in plant structures?

Comment [M19]: Response does not really address the question. Less may be more in this case to simply identify that additional study is needed, the licensee is undertaking a test program intended to provided these answer and that the OD will be updated as information becomes available

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Deleted: there is sufficient information to say that the conditions are degraded and

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Comment [M20]: Not sure what this means or how it adds value.

Comment [M21]: Doesn't address question or add value

Comment [A22]: Consider adding a statement to say that the crack indexing will provide a trending measurement for crack growth which will inform a prediction of ASR progression in the future (AB)

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Comment [A23]: Consider adding a clause specifying that the Operable but Degraded is for the structures identified in the CAL (as in, not Primary Containment) (AB)

NRC Staff Response 8

The licensee is implementing an action plan that includes literature reviews, extensive walkdowns, limited core testing, crack indexing, large-scale testing, structural assessments and evaluations, etc to comprehensively address, monitor and manage the the ASR issue at the site and to provide reasonable assurance that the affected structures remain capable of performing their safety functions through its service life. The issue of adequate baseline information and need for additional monitoring periodically and/or other actions is currently being reviewed. The results of the unrestrained core testing by the licensee and their bounding calculations were documented in reference 13, which provides the basis for NextEra's conclusion of operability but degraded.

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Comment [A24]: Same comment as A23 (AB)

The NRC staff is currently reviewing this matter as a part of the CAL follow-up inspection for which we will give a status update in a public meeting local to Seabrook in the fall of 2012.

C-10 and UCS Question 9

9. What mitigation/remediation strategies are available and what is the basis for establishing the probability of success of those strategies?

NRC Staff Response 9

Pending the NextEra acquiring adequate baseline information, adequate longer term monitoring techniques, and results of larger scale testing, there may not be a need for mitigation/remediation strategies. However the licensee has a contingency as a part of the larger scale testing program to evaluate mitigation/remediation strategies on extra specimens being produced for the larger scale testing. Reference 15 provides a summary of the scope of the testing planned at the licensee's research and development facility.

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Should mitigation/remediation strategies become necessary, we will evaluate them on a case-by-case basis.

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Page - 5 -: [1] Comment [A14] **arb6** **10/17/2012 3:31:00 PM**

I don't think this is true. It's my understanding that once a structure is placed into the ASR monitoring program, it cannot be removed from the program unless a petrographic analysis confirms no ASR. The licensee DOES use the visual criteria to exclude buildings from the ASR Monitoring Program.

Also, to answer the question better, consider stating that as part of the Structures Monitoring Program, all structures of significance are visually examined and that one of the criteria in the examination is presence of ASR, so there is the continuous ability to identify new structures to add to the ASR Monitoring Program

(AB)

- Additional core sampling – (Ref Section 3.1.2, Mechanical Testing of Cores) Additional core sampling is not planned yet by the licensee. The licensee has taken the position that mechanical testing will tell them nothing about the structural performance in-situ. However, the concrete is designed to maintain some material properties and is relied upon to work integrally with the steel to maintain structural capability. The main properties to be understood are compressive strength, tensile strength, and modulus of elasticity. While ASR effects can potentially vary for different areas, the comparison of ASR affected concrete to non-ASR affected concrete is of interest. A Canadian research effort was undertaken to provide guidance on how to relate the strength of cores to the in situ strength of concrete, including factors (multipliers) to account for various attributes of cores, e.g. microcracking caused by drilling, length-to-width ratio, moisture condition, etc. It seems that, for each building of concern (at least the safety-related or important to safety buildings), cores taken from both ASR affected areas and non-ASR affected areas can be compared to give an "apples to apples" baseline for the effect of ASR degradation for each structure compared to itself and way to compare future ASR damage. This would also give data other than surface visual indications, which may or may not accurately characterize the ASR damage. Later on, there would be a way to compare strength properties as ASR progresses, to get a better understanding of how the concrete itself is degrading. Core testing would also look for delamination of the concrete along the plane of the rebar, which cannot be indicated by visual examination.

- Structural Walkdown (Section 3.2) – No issues. Agree with licensee's methodologies presented here to determine the presence of ASR and give a preliminary qualitative measure of surface cracking. As discussed in the above bullet, more should be done in significant structures to achieve a quantitative baseline (cores, petrographic analysis of the extent of ASR degradation, strength testing, so that future data can be compared with original data)

- Effect of confinement on ASR Expansion (Section 4.1.3) – Any increase in flexural strength properties due to ASR result from the expansive stresses on the rebar causing a prestressing phenomenon where stresses in the concrete are transferred to the steel. The reinforcing steel wants to retract from the expansive stresses (in the elastic range of the steel). While this phenomenon can temporarily increase the behavior of reinforced concrete beams in flexure, the added stress on the rebar is of concern, since, unlike a prestressed concrete element, these structures were not designed for this. For structures with a small percentage of reinforcement and large expansions, the stress in the steel will be large. It is not appropriate to credit any benefit to structural behavior, especially since the licensee does not plan on inserting strain gauges to measure rebar strain and ensure that stress remains below the design strength of the rebar given other loads.

Marshall, Michael

From: Erickson, Alice
Sent: Tuesday, October 23, 2012 3:47 PM
To: Marshall, Michael; Murphy, Martin; Sheikh, Abdul; Thomas, George; Graves, Herman
Subject: Draft White Paper on ACI 318 for Comment
Attachments: DRAFT - White Paper on Applicability of ACI 318 - AErickson ASheikh (10-23-2012).docx

Follow Up Flag: Follow up
Flag Status: Completed

Categories: Review

All,

Attached is the draft white paper that has become known as the "ACI 318 Code Applicability" paper; however, I have changed the title to avoid using "applicability." Please review and provide me with any comments you may have by October 31st (It's ONLY 2.5 pages).

Thanks!

Alice Erickson
General Engineer
NRR/DLR/RASB

Mail Stop: O-11F1
Phone: (301) 415-1933
Email: Alice.Erickson@NRC.gov

B57

Assessment of ACI 318-71 as Design Basis for Category I Concrete Structures Affected by Alkali-Silica Reaction at Seabrook Station

Written By:

Alice K. Erickson

Peer Reviewed By:

Abdul Sheikh

October 23, 2012

BACKGROUND

Historically, Seabrook Station has experienced groundwater infiltration through below grade portions of concrete structures. In the early 1990's, an evaluation was conducted to assess the effect of groundwater infiltration on the serviceability of concrete walls and concluded that there would be no deleterious effect, based on the design and placement of the concrete and on the non-aggressive nature of the groundwater. However, in 2009, NextEra tested seasonal groundwater samples to support the development of the License Renewal Application (LRA) and the results showed that the groundwater had become aggressive. In conducting a comprehensive review of the possible effects on concrete structures, in early to mid-2010, the licensee performed in-situ penetration resistance testing (PRT) and compression testing of concrete cores from the affected areas in the "B" electrical tunnel of the control building. The results showed a reduction in compressive strength and modulus of elasticity of the affected concrete. In September 2010, the applicant confirmed the presence of Alkali-Silica Reaction (ASR) through petrographic examination.

The licensee has made two operability determinations to address this issue. The first addresses the reduced concrete properties below grade in the "B" electrical tunnel exterior wall, and the second addresses the reduced concrete modulus of elasticity below grade in the containment enclosure building (CEB), residual heat removal (RHR) equipment vaults, emergency feedwater (EFW) pumphouse, diesel generator fuel oil tank rooms, and other Catergory I Strucutres. These additional Category I structures, identified as having the potential presense of ASR as a result of an entent of condition survey, include the condensate storage tank enclosure, CBA east air in-take, service water cooling tower, "A" electrical tunnel, fuel storage building, east pipe chase, west pipe chase, pre-action valve room, primary auxiliary building, service water pump house, mechanical penetration area, and waste process building. As of June 2012, both operability determinations conclude that the ASR-affected structures are *operable but degraded*, and *below full qualification*. NUREG-1430, "Standard Technical Specifications," defines *operable/operability* as "...capable of performing its specified safety function." RIS 2005-20, which includes NRC Inspection Manual Part 9900 as an attachment, defines *degraded condition* as "one in which the qualification of an SSC or its functional capability is reduced." It further defines *full qualification* of an SSC as one that "conforms to all aspects of its CLB, including all applicable codes and standards, design criteria, safety analyses assumptions and specifications, and licensing commitments." Based on the definitions provided in Inspection Manual Part 9900, the "below full qualification" aspect of Seabrook Station's operability determination suggests that Seabrook Station is not meeting some aspect of its CLB.

This paper is not intended to cover all requirements that must be met for compliance with the CLB, but to focus on understanding the applicability of American Concrete Institute (ACI) 318-71, "Building Code Requirements for Structural Concrete," for which the affected structures were designed.

ACI 318-71 DOCUMENTED AS DESIGN BASIS

Seabrook Station's Updated Final Safety Analysis Report (UFSAR) Section 3.8, "Design of Category I Structures," identifies the 1971 version of American Concrete Institute 318 (ACI 318-71), "Building Code Requirements for Reinforced Concrete (with Commentary)" as the applicable design Code for Category I structures, exclusive of the containment structure. UFSAR Subsection 1.8, "Conformance to NRC Regulatory Guides" indicates that although compliance with Regulatory Guide 1.142, "Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments)" was not required and that ACI

349-76, "Code Requirements for Safety-Related Structures" was not used as a design and construction standard, the design and construction of the structures do fulfill the intent of the requirements set forth in the publication and in Regulatory Guide 1.142. Further, UFSAR Subsection 1.8 clearly indicates that the "loads and load combinations were taken directly from the USNRC Standard Review Plan and ACI 318[-71]" and that "structural analysis and design were consistent with the requirements of the [USNRC] Standard Review Plan and ACI 318[-71]."

The Seabrook Station UFSAR clearly documents the ACI 318-71 Code as the design basis for the Category I Structures. Therefore, demonstration that those structures, now affected by ASR, still meet the design requirements defined in ACI 318-71 should be sought for compliance with Seabrook Station's current licensing basis (CLB).

DISCUSSION ON ACI 318-71

ACI 318-71 is a design Code written in the context of new design and construction. The empirical relationships between concrete material properties, defined in this Code and relied upon for design, are based on performance and test data of normal concrete. These equations do not account for the effects of ASR; and therefore, should not be relied upon to demonstrate that the Code requirements are satisfied, unless proven otherwise. The technical basis for design adequacy of reinforced concrete structural systems with ASR degradation is not covered by the ACI 318-71 Code. However, ACI 318-71 Chapter 20, "Strength Evaluation of Existing Structures" does provide guidance for structural assessments when doubt develops concerning the safety of a structure. Although ACI 318-71 is a design Code, a review of this Code identified two sections as being useful in considering NextEra's approach to demonstrating that the ASR-affected structures continue to meet the intent of ACI 318-71. The following two paragraphs provide discussions on these sections.

ACI 318-71 Chapter 1, Section 1.4, "Approval of Special Systems of Design or Construction," states that "[t]he sponsors of any system of design or construction within the scope of this Code, the adequacy of which has been shown by successful use or by analysis or test, but which does not conform to or is not covered by this Code, shall have the right to present the data on which their design is based to a board of examiners appointed by the Building Official. This board shall be composed of competent engineers and shall have the authority to investigate the data so submitted, to require test, and to formulate rules governing the design and construction of such systems to meet the intent of this Code. These rules when approved by the Building Official and promulgated shall be of the same force and effect as the provisions of this Code." Section 1.2.3 of the Code defines the Building Official as "the officer or other designated authority charged with the administration and enforcement of this Code, or his duly authorized representative." ACI 318-71 does not clearly indicate whether the NRC would be considered the Building Official in this situation. Although ACI 349 "Code Requirements for Nuclear Safety-Related Concrete Structures" was not published until after Seabrook Station's design was completed, Section 1.4, which is equivalent to Section 1.4 in ACI 318-71, replaced the term "building official" with "authority having jurisdiction," which clearly identifies the NRC as having this authority in the definitions section of the Code. Regardless of this matter, it is important to note that the commentary for ACI 318-71, Section 1.4, clarifies that the provisions of this section do not apply to strength evaluation of existing structures.

ACI 318-71 Chapter 20, "Strength Evaluation of Existing Structures," Section 20.1 states that "if doubt develops concerning the safety of a structure or member, the Building Official may order a structural strength investigation by analysis or by means of load tests, or by a combination of

these methods." The general requirements for analytical investigations provided for in Section 20.2 states that "a thorough field investigation shall be made of the dimensions and details of the members, properties of the materials, and other pertinent conditions of the structure as actually built." This means that the data relied upon in the analytical investigation must be based on measured properties of the in-situ conditions of the structure. Section 20.3 provides general requirements for load tests on the built structure and Section 20.4 provides requirements for load test on flexural members. The provisions of Chapter 20, especially the load tests, are generally in the context of acceptability of concrete quality of the as-built structure at the time of original construction. Never the less, load tests on the as-built structure does not seem like an applicable approach for the Seabrook Station ASR issue, especially for the affected below-grade structures and for performance assessment in shear, bond and anchorages for embeds and supports.

ASSESSMENT

As was stated earlier, Seabrook Station's UFSAR clearly indicates that the Seismic Category I structures, exclusive of the containment structure and its internals, were designed to meet the requirements of ACI 318-71. Although this Code is written in terms of new design and construction, it is applicable in that it is the Code which defines the design basis for the Category I structures.

The intent of this paper is to communicate that the design parameters determined in accordance with ACI 318-71 must be satisfied in order for Seabrook Station to demonstrate that the ASR-affected concrete structures will perform their intended safety function; however, the empirical relationships relied upon for design purposes should not be relied upon for strength evaluation because those empirical relationships do not account for the effects of ASR. Additionally, because ACI 318-71 does not provide a technical basis for the design adequacy of ASR-affected reinforced concrete structural systems, and because NextEra's approach to demonstrating Code compliance is not consistent with the guidance described in Chapter 20 for strength evaluations, the technical basis by which NextEra demonstrates the ability of the ASR-affected structures to perform their intended safety function may require a change to the current licensing basis. However, it is the licensee's responsibility to make this determination in accordance with the regulatory requirements contained in 10 CFR, Part 50.

At this time, it does not seem necessary to seek clarification from the American Concrete Institute because discussions held with structural staff indicate that there is a general consensus and understanding of the ASR issue as it relates to the ACI 318-71 Code requirements.

Buford, Angela

From: Buford, Angela
Sent: Thursday, November 01, 2012 9:27 AM
To: Chaudhary, Suresh; Conte, Richard
Subject: No Conf Call at 9:30am

NExtEra licensee is not ready to have the discussion on the ASR Rating methodology.

B58

Thomas, George

From: Thomas, George
Sent: Thursday, November 08, 2012 6:51 AM
To: Erickson, Alice
Cc: Murphy, Martin
Subject: RE: Comments on Paper?
Attachments: DRAFT - White Paper on Applicability of ACI 318 - AErickson ASheikh (10-23-2012) gt.docx

Alice,
Attached are my comments on the paper.
Thanks.
George

From: Erickson, Alice
Sent: Thursday, November 01, 2012 12:58 PM
To: Thomas, George
Cc: Murphy, Martin
Subject: Comments on Paper?

Good Afternoon George,

I just wanted to see if DE wanted to provide comments on the draft ACI paper I sent out. Michael has told the ASR working group that he will distribute it next week so I want to make sure I have a chance to address everyone's comments. Please let me know either way.

Thanks,

Alice Erickson
General Engineer
NRR/DLR/RASB

Mail Stop: O-11F1
Phone: (301) 415-1933
Email: Alice.Erickson@NRC.gov

B59

Assessment of ACI 318-71 as Design Basis for Other Category I Concrete Structures Affected by Alkali-Silica Reaction at Seabrook Station

Written By:

Alice K. Erickson

Peer Reviewed By:

Abdul Sheikh

October 23, 2012

BACKGROUND

Historically, Seabrook Station has experienced groundwater infiltration through below grade portions of concrete structures. In the early 1990's, an evaluation was conducted to assess the effect of groundwater infiltration on the serviceability of concrete walls and concluded that there would be no deleterious effect, based on the design and placement of the concrete and on the non-aggressive nature of the groundwater. However, in 2009, NextEra tested seasonal groundwater samples to support the development of the License Renewal Application (LRA) and the results showed that the groundwater had become aggressive. In conducting a comprehensive review of the possible effects on concrete structures, in early to mid-2010, the licensee performed in-situ penetration resistance testing (PRT) and compression testing of concrete cores from the affected areas in the "B" electrical tunnel of the control building. The results showed a reduction in compressive strength and modulus of elasticity of the affected concrete. In September 2010, the applicant confirmed the presence of Alkali-Silica Reaction (ASR) through petrographic examination.

The licensee has made two prompt operability determinations (PODs) to address the effects of this issue for potentially affected structures. The first addresses the reduced concrete properties below grade in the "B" electrical tunnel exterior wall, and the second addresses the reduced concrete modulus of elasticity below grade in the containment enclosure building (CEB), residual heat removal (RHR) equipment vaults, emergency feedwater (EFW) pumphouse, diesel generator fuel oil tank rooms, and some additional other Catergory I Structutres. These additional Category I structures, identified as having the potential ~~presense~~ presence of ASR as a result of an ~~entent~~ extent of condition survey, include the condensate storage tank enclosure, CBA east air in-take, service water cooling tower, "A" electrical tunnel, fuel storage building, east pipe chase, west pipe chase, pre-action valve room, primary auxiliary building, service water pump house, mechanical penetration area, and waste process building. Except for the primary containment structure, the Seabrook concrete structures that have been identified thus far as affected or potentially affected by ASR generally fall under the classification of "Other Category 1 Structures" described in UFSAR Section 3.8.4. As of June 2012, both prompt operability determinations conclude that the ASR-affected structures are *operable but degraded*, and *below full qualification*. NUREG-1430, "Standard Technical Specifications," defines *operable/operability* as "...capable of performing its specified safety function." RIS 2005-20, Revision 1, which includes NRC Inspection Manual Part 9900 as an attachment, defines *degraded condition* as "one in which the qualification of an SSC or its functional capability is reduced." It further defines *full qualification* of an SSC as one that "conforms to all aspects of its CLB, including all applicable codes and standards, design criteria, safety analyses assumptions and specifications, and licensing commitments." Based on the definitions provided in Inspection Manual Part 9900, the "below full qualification" aspect of Seabrook Station's operability determination suggests that Seabrook Station is not meeting some aspect of its CLB. The licensee will have to resolve the current PODs with respect to the CLB, in accordance with its procedures for operability determinations and functionality assessments, as part of its action plan to comprehensively address and manage the ASR degradation issue at the site.

This paper is not intended to cover all requirements that must be met for compliance with the CLB, but to focus on understanding the applicability of American Concrete Institute (ACI) 318-71, "Building Code Requirements for Structural Concrete," ~~for~~ to which the affected structures were designed.

ACI 318-71 DOCUMENTED AS DESIGN BASIS

Seabrook Station's Updated Final Safety Analysis Report (UFSAR) Section 3.8, "Design of Category I Structures," identifies the 1971 version of American Concrete Institute 318 (ACI 318-71), "Building Code Requirements for Reinforced Concrete (with Commentary)" as the applicable ~~design~~ Construction Code for Category I structures, exclusive of the containment structure. UFSAR Subsection 1.8, "Conformance to NRC Regulatory Guides" indicates that although compliance with Regulatory Guide 1.142, "Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments)" was not required and that ACI 349-76, "Code Requirements for Safety-Related Structures" was not used as a design and construction standard, the design and construction of the structures do fulfill the intent of the requirements set forth in the publication and in Regulatory Guide 1.142. Further, UFSAR Subsection 1.8 clearly indicates that the "loads and load combinations were taken directly from the USNRC Standard Review Plan and ACI 318[-71]" and that "structural analysis and design were consistent with the requirements of the [USNRC] Standard Review Plan (SRP) [NUREG-0800] and ACI 318[-71]."

The Seabrook Station UFSAR clearly documents the [ultimate] strength design method of ACI 318-71 Code along with the NUREG-0800 SRP as the design basis for the Category I Structures except the primary containment. The basic load combinations considered in the design basis of each seismic Category 1 structure are given in UFSAR Table 3.8-16. Therefore, demonstration that those structures, now affected by ASR, still meet the strength design requirements ~~defined in~~of ACI 318-71 under design basis loads and load combinations in the UFSAR should be sought for compliance with Seabrook Station's current licensing basis (CLB).

DISCUSSION ON ACI 318-71

ACI 318-71 is a ~~design~~ Construction Code written in the context of new design and construction. The empirical relationships between concrete compressive strength and other material/mechanical properties (such as tensile strength, shear strength, bond, modulus of elasticity etc.), defined in this Code and relied upon for design, are based on performance and test data of normal concrete. These equations do not account for the effects of ASR; and therefore, should not be relied upon to demonstrate that the Code requirements are satisfied, unless proven otherwise. The technical basis for establishing design adequacy of reinforced concrete structural systems with ASR degradation, using the 318 code provisions, is not covered by the ACI 318-71 Code. However, ACI 318-71 Chapter 20, "Strength Evaluation of Existing Structures" does provide guidance for structural assessments when doubt develops concerning the safety of a structure. Although ACI 318-71 is a ~~design~~ Construction Code, a review of this Code identified two sections as being useful in considering NextEra's approach to demonstrating that the ASR-affected structures continue to meet the intent of ACI 318-71. The following two paragraphs provide discussions on these sections.

ACI 318-71 Chapter 1, Section 1.4, "Approval of Special Systems of Design or Construction," states that "[t]he sponsors of any system of design or construction within the scope of this Code, the adequacy of which has been shown by successful use or by analysis or test, but which does not conform to or is not covered by this Code, shall have the right to present the data on which their design is based to a board of examiners appointed by the Building Official. This board shall be composed of competent engineers and shall have the authority to investigate the data so submitted, to require test, and to formulate rules governing the design and construction of such systems to meet the intent of this Code. These rules when approved by the Building Official and promulgated shall be of the same force and effect as the provisions of this Code." Section 1.2.3 of the Code defines the Building Official as "the officer or other designated

authority charged with the administration and enforcement of this Code, or his duly authorized representative." By law, the NRC has the regulatory jurisdiction over commercial nuclear power plants in the US. Concrete structures important-to-safety have been licensed by the NRC to ACI 318-71 for several earlier plants. ~~ACI 318-71 does not clearly indicate whether~~ Therefore, in the context of the code, the NRC would logically be considered the Building Official in this situation. Also, even ~~A~~although ACI 349 "Code Requirements for Nuclear Safety-Related Concrete Structures" was not published until after Seabrook Station's design was completed, Section 1.4, which is equivalent to Section 1.4 in ACI 318-71, replaced the term "building official" with "authority having jurisdiction.," This is because the ACI 349 code adapted and applied most of its provisions from ACI 318 specifically for nuclear safety-related structures (with exception of containment) ~~which clearly~~and, therefore, explicitly identifies the NRC as having this authority in the definitions section of the Code. Regardless ~~of this matter~~, it is important to note that the commentary for ACI 318-71, Section 1.4, clarifies that the provisions of this section do not apply to strength evaluation of existing structures under Chapter 20.

ACI 318-71 Chapter 20, "Strength Evaluation of Existing Structures," Section 20.1 states that "if doubt develops concerning the safety of a structure or member, the Building Official may order a structural strength investigation by analysis or by means of load tests, or by a combination of these methods." The general requirements for analytical investigations provided for in Section 20.2 states that "a thorough field investigation shall be made of the dimensions and details of the members, properties of the materials, and other pertinent conditions of the structure as actually built." This means that the data relied upon in the analytical investigation must be based on measured properties of the in-situ conditions of the structure. Section 20.3 provides general requirements for load tests on the built structure and Section 20.4 provides requirements for load test on flexural members. The provisions of Chapter 20, especially the load tests, are generally in the context of acceptability of concrete quality of the as-built structure at the time of original construction. Never the less, load tests on the as-built structure does not seem like an applicable approach for the Seabrook Station ASR issue, especially for the affected below-grade structures and for performance assessment in shear, bond and anchorages for embeds and supports.

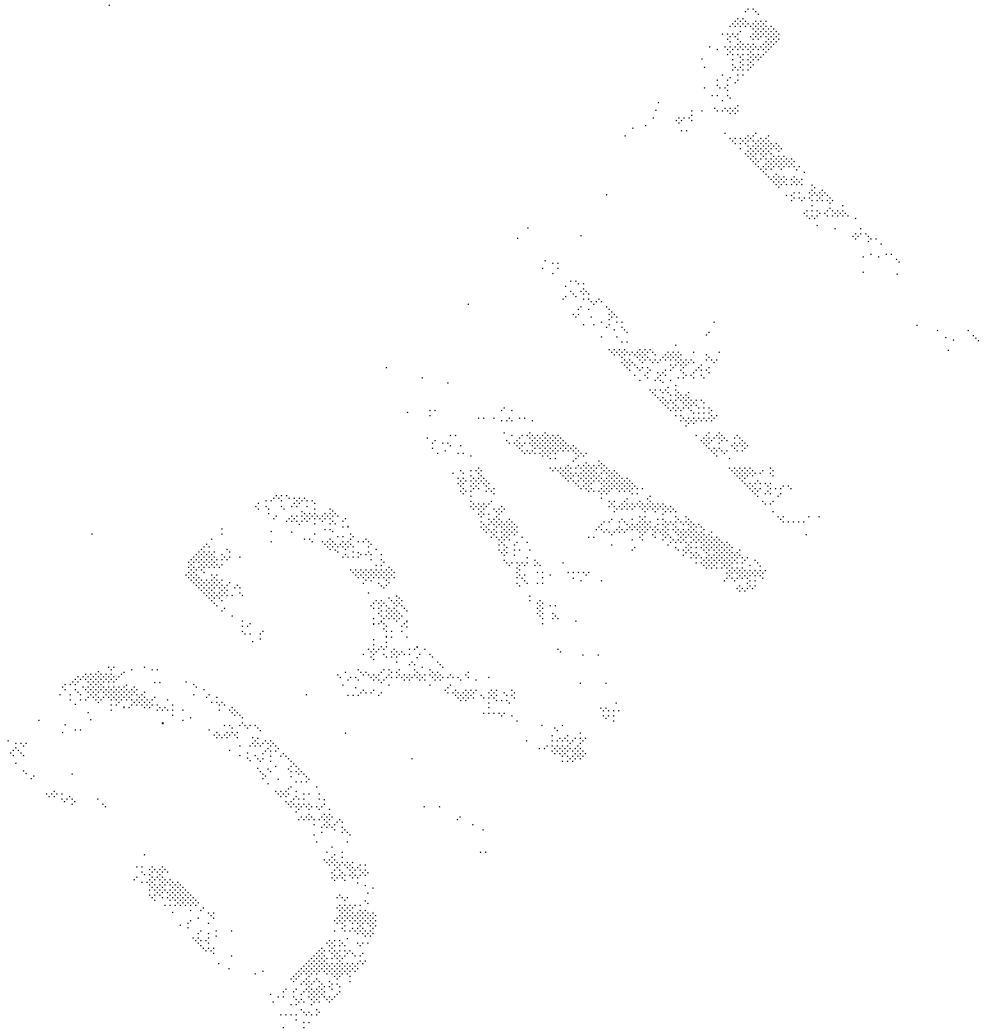
ASSESSMENT

As was stated earlier, Seabrook Station's UFSAR clearly indicates that the Seismic Category I concrete structures, exclusive of the containment structure ~~and its internals~~, were designed to meet the strength design requirements of ACI 318-71. ~~A~~although As such, this Code ~~is written in terms of new design and construction, it~~ is applicable in that it is the Construction Code-of-Record ~~which defines~~that forms the current licensing design basis for the Category I structures.

The intent of this paper is to communicate that the strength design ~~parameters determined in accordance with~~provisions of ACI 318-71 must be satisfied in order for Seabrook Station to demonstrate that the ASR-affected concrete structures will perform their intended safety function within the CLB; however, unless proven otherwise, the empirical relationships in the design provisions of the code ~~relied upon~~ should be treated with caution ~~for design purposes~~ and should not be relied upon for strength evaluation because those empirical relationships do not account for the effects of ASR. Additionally, because ACI 318-71 does not provide a technical basis for establishing the design adequacy of ASR-affected reinforced concrete structural systems using its strength design provisions, and because NextEra's approach to demonstrating Code compliance is not consistent with the guidance described in Chapter 20 for strength evaluations, the technical basis by which NextEra demonstrates the ability of the ASR-affected structures to perform their intended safety function may require a change to the current

licensing basis in the resolution of the current PODs. However, it is the licensee's responsibility to make this determination by evaluating its proposed approach in establishing the long-term design adequacy of ASR-affected structures with respect to the ACI 318-71 code and in accordance with the regulatory requirements contained in 10 CFR, Part 50.59 "Changes, tests and experiments."

At this time, it does not seem necessary to seek clarification from the American Concrete Institute because discussions held with structural staff indicate that there is a general consensus and understanding of the ASR issue as it relates to the ACI 318-71 Code requirements.



Marshall, Michael

From: Erickson, Alice
Sent: Friday, November 09, 2012 7:56 AM
To: Marshall, Michael
Subject: ACI Paper (in track changes)
Attachments: DRAFT - Assessment of ACI 318-71 as Design Basis - AErickson ASheikh HGraves GThomas MMarshall (11-9-2012).docx

Michael,

I decided to work for a couple of hours this morning to finish up the ACI 318 paper. I have attached the revised paper, which incorporates Abdul, Herman, George, and your comments. To address your comment to add the information related to the intent of the testing, I decided to add a paragraph to address it, rather than adding the information into the background and assessment sections. Please note that the addition of that information hasn't been peer reviewed by Abdul, Herman, or George.

Also, I didn't ignore your suggestion to re-word one of my concluding sentences in the assessment portion, I just prefer to keep it as one sentence.

We told Rich we would send the paper to the ASR Working group this week; however, as I mentioned on Tuesday, we received comments for DE later that we had expected pushing me back a bit. If you have any further comments you would like me to address today, please call, otherwise we can discuss on Tuesday.

Thanks and have a great weekend!

Alice

B60

Marshall, Michael

From: Murphy, Martin
Sent: Thursday, November 15, 2012 8:42 AM
To: Marshall, Michael
Subject: FW: asr
Attachments: RE: Revised Cartoon for OD Margins Approach

George and Angie have seen that diagram. I know I need my folks to keep me better informed.

From: Thomas, George
Sent: Thursday, November 15, 2012 8:30 AM
To: Murphy, Martin
Subject: RE: asr

Bill Cook had asked for some quick feedback from inspection team members (Raymond, Angie and myself) on a previous version of it, for his inspection exit meeting at site. Attached is the feedback I provided.

From: Murphy, Martin
Sent: Thursday, November 15, 2012 7:56 AM
To: Thomas, George
Subject: RE: asr

Have you seen it?

From: Thomas, George
Sent: Thursday, November 15, 2012 7:56 AM
To: Murphy, Martin
Subject: RE: asr

Ok, will stop-by to discuss Monday.

From: Murphy, Martin
Sent: Thursday, November 15, 2012 6:31 AM
To: Thomas, George
Subject: FW: asr

With attachment would help

From: Murphy, Martin
Sent: Thursday, November 15, 2012 6:31 AM
To: Thomas, George
Subject: asr

George,
Have you seen this graphical representation of the capacity vs demands(?) associated with seabrook?

Lets discuss this next time we are both in the office. Likely Monday 11/19

B61

Thomas, George

From: Thomas, George
Sent: Friday, November 16, 2012 2:01 PM
To: Murphy, Martin
Subject: FW: RESPONSE: Applicability of ACI 318-71 Paper
Attachments: Assessment of ACI 318-71 as Design Basis - AErickson ASheikh HGraves GThomas MMarshall (11-9-2012).doc; ACI 318-71 USD and ASR Conceptual Schematic GT 11-16-12.docx

Marty,

Giving some more thought TO this ACI 318-71 applicability paper (first attachment to this email) that Mike Marshall sent out, I thought it would be useful to incorporate a conceptual schematic that I developed (second attachment to this email) on how the intent of the code could be met for ASR-affected structures. This is for your review/feedback and has not been sent to anybody else. We can discuss this also Monday afternoon.

Thanks.
George

From: Marshall, Michael
Sent: Wednesday, November 14, 2012 2:14 PM
To: Cook, William; Conte, Richard
Cc: Erickson, Alice; Murphy, Martin; Raymond, William; Thomas, George; Graves, Herman; Sheikh, Abdul
Subject: RESPONSE: Applicability of ACI 318-71 Paper

Hello Rich and Bill,

Attached is the paper that we agreed to produce concerning the applicability of ACI 318-71. The paper has been peered reviewed by the cognizant staff in DE, DLR, and RES. Please, feel free to circulate the paper among the Seabrook ASR Issue Working Group as you see fit.

Best Regards,

Michael L. Marshall, Jr.
Chief
Aging Management of Structures, Electrical, and Systems Branch
Division of License Renewal
Office of Nuclear Reactor Regulation

301-415-2871
Email: michael.marshall@nrc.gov

B62

Assessment of ACI 318-71 as Design Basis for Category I Concrete Structures Affected by Alkali-Silica Reaction at Seabrook Station

Written By:

Alice K. Erickson

Peer Reviewed By:

Abdul Sheikh

Herman Graves

George Thomas

November 9, 2012

BACKGROUND

Historically, Seabrook Station has experienced groundwater infiltration through below grade portions of concrete structures. In the early 1990's, an evaluation was conducted to assess the effect of groundwater infiltration on the serviceability of concrete walls and concluded that there would be no deleterious effect, based on the design and placement of the concrete and on the non-aggressive nature of the groundwater. However, in 2009, NextEra tested seasonal groundwater samples to support the development of the License Renewal Application (LRA) and the results showed that pH values were between 5.8 and 7.5, chloride values were between 19 ppm and 3900 ppm, and sulfate values between 10 ppm and 100 ppm, indicating that the groundwater had become aggressive [pH < 5.5, chlorides > 500 ppm, or sulfates > 1500 ppm]. Subsequently, in conducting a comprehensive review of the possible effects on concrete structures, in early to mid-2010, the licensee performed in-situ penetration resistance testing (PRT) and compression testing of concrete cores from the affected areas in the "B" electrical tunnel of the control building. The results showed a reduction in compressive strength and modulus of elasticity of the affected concrete. In September 2010, the applicant confirmed the presence of Alkali-Silica Reaction (ASR) through petrographic examination of samples taken from the concrete cores of the "B" electric tunnel.

The licensee has made two prompt operability determinations (PODs) to address the effects of this issue for potentially affected structures. The first addresses the reduced concrete properties below grade in the "B" electrical tunnel exterior wall, and the second addresses the reduced concrete modulus of elasticity below grade in the containment enclosure building (CEB), residual heat removal (RHR) equipment vaults, emergency feedwater (EFW) pumphouse, diesel generator fuel oil tank rooms, and some additional other Catergory I Structures. These additional Category I structures, identified as having the potential presence of ASR as a result of an extent of condition survey, include the condensate storage tank enclosure, control building makeup air intake, service water cooling tower, "A" electrical tunnel, fuel storage building, east pipe chase, west pipe chase, pre-action valve room, primary auxiliary building, service water pump house, mechanical penetration area, and waste process building. Except for the primary containment structure, the Seabrook concrete structures that have been identified thus far as affected or potentially affected by ASR generally fall under the classification of "Other Category 1 Structures" described in UFSAR Section 3.8.4. As of June 2012, both PODs conclude that the ASR-affected structures are *operable but degraded*, and *below full qualification*. NUREG-1430, "Standard Technical Specifications," defines *operable/operability* as "...capable of performing its specified safety function." RIS 2005-20, Revision 1, which includes NRC Inspection Manual Part 9900 as an attachment, defines *degraded condition* as "one in which the qualification of an SSC or its functional capability is reduced." It further defines *full qualification* of an SSC as one that "conforms to all aspects of its CLB, including all applicable codes and standards, design criteria, safety analyses assumptions and specifications, and licensing commitments." Based on the definitions provided in Inspection Manual Part 9900, the "below full qualification" aspect of Seabrook Station's operability determination suggests that Seabrook Station is not meeting some aspect of its CLB. The licensee will have to resolve the current PODs with respect to the CLB, in accordance with its procedures for operability determinations and functionality assessments, as part of its action plan to comprehensively address and manage the ASR degradation issue at the site.

This paper is not intended to cover all requirements that must be met for compliance with the CLB, but to focus on understanding the applicability of American Concrete Institute (ACI) 318-

71, "Building Code Requirements for Structural Concrete," to which the affected structures were designed.

ACI 318-71 DOCUMENTED AS DESIGN BASIS

Seabrook Station's Updated Final Safety Analysis Report (UFSAR) Section 3.8, "Design of Category I Structures," identifies the 1971 version of American Concrete Institute 318 (ACI 318-71), "Building Code Requirements for Reinforced Concrete (with Commentary)" as the applicable Construction Code for Category I structures, exclusive of the containment structure. UFSAR Subsection 1.8, "Conformance to NRC Regulatory Guides" indicates that although compliance with Regulatory Guide 1.142, "Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments)" was not required and that ACI 349-76, "Code Requirements for Safety-Related Structures" was not used as a design and construction standard, the design and construction of the structures do fulfill the intent of the requirements set forth in the publication and in Regulatory Guide 1.142. Further, UFSAR Subsection 1.8 clearly indicates that the "loads and load combinations were taken directly from the USNRC Standard Review Plan and ACI 318[-71]" and that "structural analysis and design were consistent with the requirements of the [USNRC] Standard Review Plan (SRP) [NUREG-0800] and ACI 318[-71]."

The Seabrook Station UFSAR clearly documents the [ultimate] strength design method of ACI 318-71 Code along with the NUREG-0800 SRP as the design basis for the Category I Structures, except the primary containment. The basic load combinations considered in the design basis of each seismic Category 1 structure are given in UFSAR Table 3.8-16. Therefore, demonstration that those structures now affected by ASR still meet the strength design requirements of ACI 318-71 under design basis loads and load combinations in the UFSAR, should be sought for compliance with Seabrook Station's current licensing basis (CLB).

DISCUSSION ON ACI 318-71

ACI 318-71 is a Construction Code written in the context of new design and construction. The empirical relationships between concrete compressive strength and other material/mechanical properties (such as tensile strength, shear strength, bond, modulus of elasticity etc.), defined in this Code and relied upon for design, are based on performance and test data of normal concrete. These equations do not account for the effects of ASR; and therefore, should not be relied upon to demonstrate that the Code requirements are satisfied, unless proven otherwise. The technical basis for establishing design adequacy of reinforced concrete structural systems with ASR degradation is not covered by the ACI 318-71 Code. However, ACI 318-71 Chapter 20, "Strength Evaluation of Existing Structures" does provide guidance for structural assessments when doubt develops concerning the safety of a structure. Although ACI 318-71 is a Construction Code, a review of this Code identified two sections as being useful in considering NextEra's approach to demonstrating that the ASR-affected structures continue to meet the intent of ACI 318-71.

ACI 318-71 Chapter 1, Section 1.4, "Approval of Special Systems of Design or Construction," states that "[t]he sponsors of any system of design or construction within the scope of this Code, the adequacy of which has been shown by successful use or by analysis or test, but which does not conform to or is not covered by this Code, shall have the right to present the data on which their design is based to a board of examiners appointed by the Building Official. This board shall be composed of competent engineers and shall have the authority to investigate the data so submitted, to require test, and to formulate rules governing the design and construction of

such systems to meet the intent of this Code. These rules when approved by the Building Official and promulgated shall be of the same force and effect as the provisions of this Code." Section 1.2.3 of the Code defines the Building Official as "the officer or other designated authority charged with the administration and enforcement of this Code, or his duly authorized representative." By law, the NRC has the regulatory jurisdiction over commercial nuclear power plants in the US. Concrete structures important-to-safety have been licensed by the NRC to ACI 318-71 for several earlier plants. Therefore, in the context of the Code, the NRC would logically be considered the Building Official in this situation. Also, even though ACI 349 "Code Requirements for Nuclear Safety-Related Concrete Structures" was not published until after Seabrook Station's design was completed, Section 1.4, which is equivalent to Section 1.4 in ACI 318-71, replaced the term "building official" with "authority having jurisdiction." This is because the ACI 349 Code adapted and applied most of its provisions from ACI 318 specifically for nuclear safety-related structures (with exception of containment) and, therefore, explicitly identifies the NRC as having this authority in the definitions section of the Code. Regardless, it is important to note that the commentary for ACI 318-71, Section 1.4, clarifies that the provisions of this section do not apply to strength evaluation of existing structures under Chapter 20.

ACI 318-71 Chapter 20, "Strength Evaluation of Existing Structures," Section 20.1 states that "if doubt develops concerning the safety of a structure or member, the Building Official may order a structural strength investigation by analysis or by means of load tests, or by a combination of these methods." The general requirements for analytical investigations provided for in Section 20.2 states that "a thorough field investigation shall be made of the dimensions and details of the members, properties of the materials, and other pertinent conditions of the structure as actually built." This means that the data relied upon in the analytical investigation must be based on measured properties of the in-situ conditions of the structure. Section 20.3 provides general requirements for load tests on the built structure and Section 20.4 provides requirements for load test on flexural members. The provisions of Chapter 20, especially the load tests, are generally in the context of acceptability of concrete quality of the as-built structure at the time of original construction. Never the less, load tests on the as-built structure does not seem like a practicable approach for the Seabrook Station ASR issue, especially for the affected below-grade structures and for performance assessment in shear, bond and anchorages for embeds and supports.

INTENT OF TESTING BEING CONDUCTED

In a public meeting held on April 23, 2012 to discuss the plans and schedule regarding concrete degradation due to ASR, NextEra presented several statements in their slides that provide some insight as to the intent of the testing being conducted at the University of Texas. The following statements indicate that the testing will be used to support resolution of the PODs and to provide some basis for demonstrating that the effects of aging will be adequately managed for license renewal:

> Ongoing full scale testing is expected to validate assumptions and identify additional margin.
>
> Testing is anticipated to show that the performance of ASR-affected concrete structures is not compromised.

Design parameters for ASR affected concrete [derived from ASR-affected and control beams] will be compared to ACI Construction Code requirements and reconciled with Seabrook design basis calculations.

AMP criteria and frequency will be revised as the full-scale concrete beam test program develops.

Ongoing testing programs are expected to identify additional structural margin.

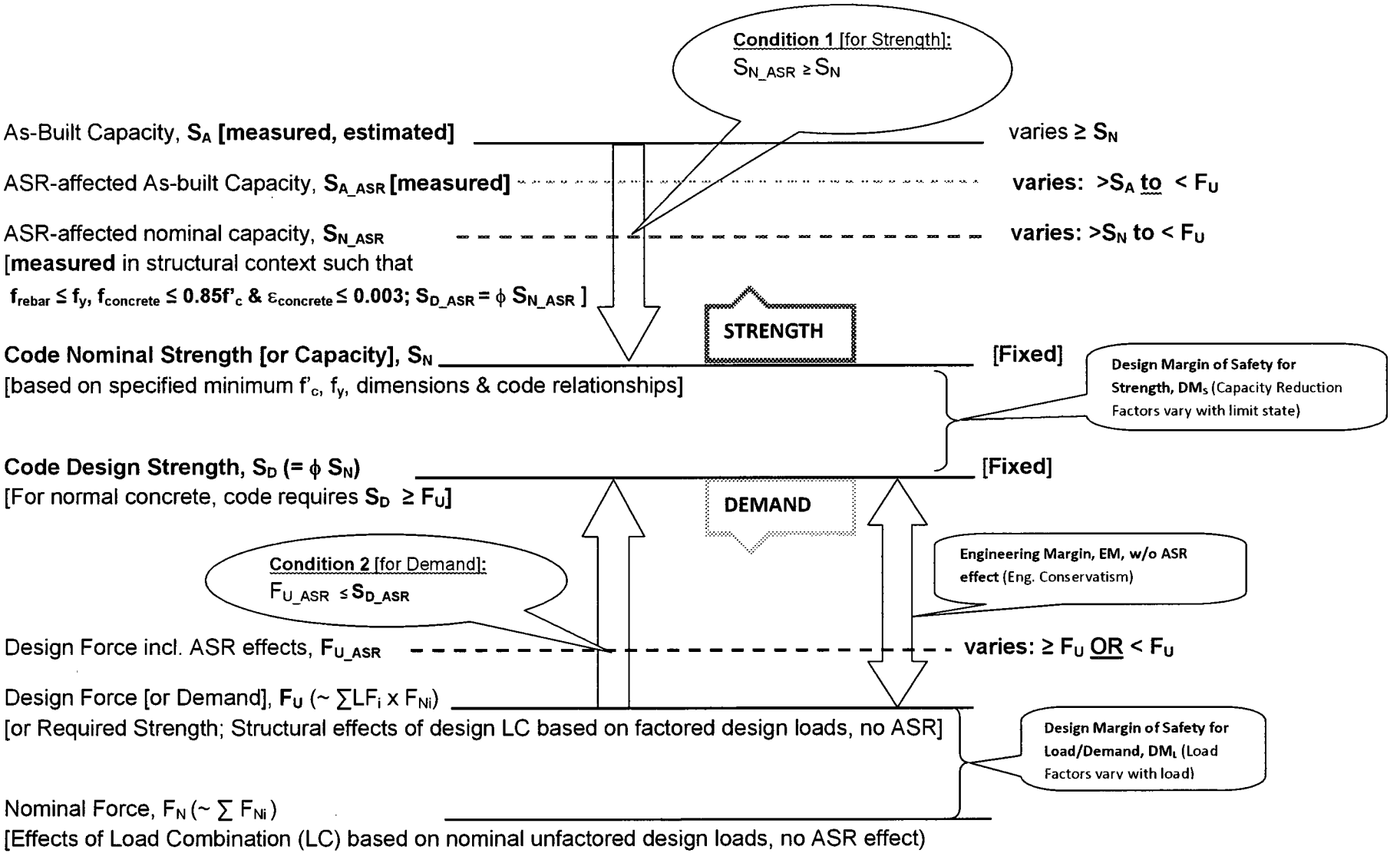
Based on this information, the staff understands that the testing being conducted at the University of Texas will be used in the resolution of the PODs. However, the details as to how the testing will support the resolution of the PODs remain unclear to the staff. The staff also understands that the testing will no longer serve as a basis for the development of their aging management program; however, the results of the testing may inform certain elements of the program that NextEra is currently proposing.

ASSESSMENT

As was stated earlier, Seabrook Station's UFSAR clearly indicates that the Seismic Category I concrete structures, exclusive of the containment structure, were designed to meet the strength design requirements of ACI 318-71. As such, this Code is applicable in that it is the Construction Code-of-Record that forms the current licensing design basis for the Category I structures.

The intent of this paper is to communicate that the strength design provisions of ACI 318-71 must be satisfied in order for Seabrook Station to demonstrate that the ASR-affected concrete structures will perform their intended safety function within the CLB; however, unless proven otherwise, the empirical relationships in the design provisions of the Code should be treated with caution and should not be relied upon for strength evaluation because those empirical relationships do not account for the effects of ASR. Additionally, because ACI 318-71 does not provide a technical basis for establishing the design adequacy of ASR-affected reinforced concrete structural systems using its strength design provisions, and because NextEra's approach to demonstrating Code compliance is not consistent with the guidance described in Chapter 20 for strength evaluations, the technical basis by which NextEra demonstrates the ability of the ASR-affected structures to perform their intended safety function may require a change to the current licensing basis in the resolution of the current PODs. However, it is the licensee's responsibility to make this determination by evaluating its proposed approach in establishing the long-term design adequacy of ASR-affected structures with respect to the ACI 318-71 code and the regulatory requirements contained in 10 CFR 50.59 "Changes, tests and experiments."

At this time, it does not seem necessary to seek clarification from the American Concrete Institute because, as presented in this paper, the staff has a generally agreed upon position and understanding of the ASR issue as it relates to the ACI 318-71 Code requirements.



Conceptual Application of Intent of ACI 318-71 Strength Design to ASR-Affected Structures

[Satisfy Conditions 1 & 2 to meet code intent - See Notes on next page]

Notes:

1. ϕ – capacity (or strength) reduction factor for each limit state (axial, flexure, shear, etc.); LF – Load factors associated with loads in design load combinations (LC)
2. Per code, f'_c and f_y are specified minimum concrete compressive strength and rebar yield strength, respectively.
3. Strength design of ACI 318-71 basically requires **"Design Strength greater than or equal to Required Strength"** (i.e., $\mathbf{S_D \geq F_U}$) for each limit state, in addition to serviceability requirements.
4. ASR could affect code empirical relationships as well as could cause change in: (1) actual and nominal structural capacity (($\mathbf{S_A}$, $\mathbf{S_N}$)$\rightarrow$($\mathbf{S_{A\_ASR}}$, $\mathbf{S_{N\_ASR}}$)) and (2) structural demand ($\mathbf{F_U \rightarrow F_{U\_ASR}}$), for each limit state. To meet the intent of ACI 318-71 for ASR-affected concrete components, Conditions (1) $\mathbf{S_{N\_ASR} \geq S_N}$ **and** (2) $\mathbf{F_{U\_ASR} \leq S_{D\_ASR}}$ should be **satisfied through the service life** for each strength limit state; such that $\mathbf{S_{N\_ASR}}$ **is obtained independent of code-relationships for** $\mathbf{S_N}$ (such as measured in structural context by large-scale testing) and measured maximum stresses and strain corresponding S_{N_ASR} are shown to be $f_{rebar} \leq f_y$, $f_{concrete} < 0.85f'_c$ and $\varepsilon_{concrete} \leq 0.003$; and $\mathbf{S_{D\_ASR} = \phi S_{N\_ASR}}$. This criteria would ensure that code design margins of safety for both strength and structural demand are preserved.
5. Large-scale beam testing plan should include consideration that the limited number of large-scale specimens tested addresses the intent of the statistical basis in Chapter 4 of ACI 318-71 for concrete quality and strength design.