Seabrook Station License Amendment

Docket No. 50-443-LA2

Comments from Paul Brown, C-10 Foundation's Notes of Questions for Paul Brown, as summarized from ML122070401: Transcript of the ACRS Plant License Renewal Subcommittee Meeting (Open), Page 1-179 (July 10, 2012)

ATTACHMENT A

Advisory Committee for Reactor Safeguard - Meeting, July 10, 2012
C-10 Foundation's Notes of Questions for Paul Brown, as Summarized from ML122070401: Transcript of the ACRS Plant License Renewal Subcommittee Meeting, July 10, 2012 (Open) Page 1-179.
https://www.nrc.gov/docs/ML1220/ML122070401.pdf

Page 24:
When asked by ACRS member why NextEra was not inspecting the containment building concrete during this next Sept 23rd refueling 2012. NextEra replied because the UT exams done of Seabrook's containment liner for thickness in 120 locations did not demonstrate any change in thickness. It was done in Sept 2011. Is that adequate? Does it define that the steel liner is intact? Are there better tests? Regardless, it does not address the presence of ASR in containment concrete or its extent with acceptable criteria.

The determination of the absence of a change in thickness depends on the resolution of the measurement. This can be as little as 0.1 mm so the determinations are probably ok. However, it seems that there are still a number of bases for concern. It would be useful to have the mapping of the locations where the measurements were done to have assurance that they were done at locations where the liner would be consider vulnerable to corrosion because of the contact with ground water. Based on the testimony on page 57, they did ultrasonic testing at random locations but did not concentrated on testing in apposition to locations that had been previously water filled. I am surprised that no analyses of the water have been done. Based on prior information the water at the site ranges from rather innocuous to aggressive with respect to its ability to induce corrosion of embedded steel. The depth of concrete cover over reinforcement needs to be greater if an exposure condition involving chloride is anticipated. So while the liner itself may not be showing significant corrosion, there is no assurance that this can be generalized to the reinforcement in the concrete walls or slab. I am also surprised that no one raised a concern regarding the mechanism of water ingress. How is it getting into this space? And what is the condition of the concrete and embedded steel in this or in these locations? Lastly, why hasn't the interior space been surveyed and photodocumented, at least remotely, to establish whether the containment concrete is undergoing the alkali-silica reaction?

On pages 57-67 NextEra personnel and their expert discuss the ASR issue and the analyses done. They also note that concrete does not need to be immersed in water to undergo ASR. All that is needed is a high relative humidity environment. They say a minimum of 90% r.h. is needed but it is lower than that.

On page 67, Dr. Bayrak speaks to ASR and his observations that ASR can be more severe when the concrete is subjected to wetting and drying.

On page 71 Mr. Noble suggests that, because ASR presents a high pH, the reinforcing steel is in a passive state so there little concern for its corrosion. While this is correct, it is not complete. Eventually the crack network will allow ingress of aggressive species. These could include chloride but also CO_2. Once the concrete adjacent to the steel becomes carbonated, the steel will not be passive and, if the internal pH is elevated, corrosion will initiate.

On pages 73-74, they say that no corrosion of embedded steel has yet been observed after cover concrete had been removed. While this is comforting, it would useful to know something about the chloride content of the local ground water.

I am concerned that the NextEra side is regarding ASR as a linear phenomenon. There is some period during which the occurrence of ASR does not cause cracking and actually results in higher strength when compared to a control sample not experiencing ASR. But as the available local pore volumes become filled, cracking initiates. My point is that, because there is an induction period, crack formation and growth are not linear with time.

If the concrete is unrestrained, the cracks grow. If the concrete is restrained, the cracks do not grow as widely because of the restraint, but there are more of them. This process can be regarded as turning the concrete into mush. Consequently, the analyses needed to be more sophisticated than just determinations of crack displacement. Crack displacement determinations are probably adequate for assessing the damage to the cover concrete. However, mechanical testing of extracted to establish compressive strengths and determinations of the changes in Young's modulus are more appropriate for the restrained concrete.

Page 97. I think there is a basis for concern here. The assumption underlying their analysis of ASR in regions of concrete constrained by rebar is that it will produce ever widening cracks on the surface. I am not confident that this will be the case. Thus, their protocol may not actually be a reasonable indicator of ASR progression.

Page 100. The claim that ASR stiffens the structure may be presently true, but its eventual progression is likely to "soften" the structure as the modulus of the concrete is reduced.

Page 106. I fully agree that the reinforcing steel will influence the crack displacement by confining the concrete within the steel cages. However, I disagree with the view that it is invalid to remove cores and test them. Testing in a restrained environment is not really assessing the strength of the concrete itself.

Page145.
Accumulation of water in the annulus space can degrade the containment liner and accelerate degradation of concrete. Paul, see slide schematic of Seabrook containment in the back of the document to define tests required and where to define extent of degradation of concrete and steel.

The locations of the ultrasonic testing of the liner were not provided. Rebar was only exposed in limited areas after removing the concrete cover. The relationship between these locations and those where there is a potential chloride exposure was not reported. The crack displacement (width) criteria may not be a very good predictor of ASR for the reasons I have already discussed.

Page 149
Staff disagrees with applicant's presentation. Staff believes that the applicant should address the effects of ASR in concrete containment and the aging management program does not include trending data to determine extent and rate of degradation of mechanical properties from tests. Paul, how best?

I don't think there is anything wrong with the tests they propose: crack displacement mapping, ultrasonic testing of the liner, and accelerating testing at Univ Texas. But I think their testing protocol is incomplete. Ongoing strength testing should be done. Nondestructive testing for corrosion of rebar should be done. In view of the extent of the reinforcement and the associated constraints on expansion, reliance on crack widening needs to be proven to be a reliable indicator of ASR progression.

Page151
NextEra has known about it (ASR concrete) for awhile, even prior to the license renewal.

I think ASR will be found at other plants

Page154
Starts Abdul Sheikh's statements begin. They are key.

Page155
Reduced compression strength, reduced tensile and shear strength, reduced bond strength and elastic modulus of the concrete. Degradation is pronounced.

Page156
Original design was based on non-ASR concrete.

He is correct. Expansive degradative mechanisms alter the relationship between the compressive and tensile properties of concrete. For example concrete

subjected to sulfate attack exceeded the compressive strength of a control concrete but showed a marked loss in splitting tensile strength. You could test a stack of coins in compression, but they would just fall apart in splitting tension.

I don't necessarily agree with his statement regarding cathodic protection. This process feeds electrons to the steel and is understood to redistribute ionic species in concrete. So if there is an external source of sodium, its migration into the concrete could well be enhanced.

Page158
What new ASDM standard can detect expansive aggregate?

I think they mean ASTM standard. C9 has been working on this for awhile.

Page158
80 feet of groundwater intrusion statement. Repeat eight-zero!

This certainly does seem to be significant.

Page159
Seabrook dos not have a groundwater dewatering system which could prevent the ingress of water into the buildings.

For ASR it might not matter that much. But if the ground water is corrosive, reducing ingress could have a significant effect.

Page160
Recently, NextEra informed NRC staff that they have cracks in concrete exposed to water in containment. No evaluation has been performed on containment's structural integrity if ASR is present.

One or the difficulties in trying to figure out the actual conditions of the various buildings is the information provided is of a rather general nature. I think the process would benefit by the disclosure of a detailed structure-by-structure conditional assessment.

Page166
NRC staff reports.compression strength more loss than reported. The applicant states it is due to different labs. The NRC staff disagrees. Paul needs to look at the basis. NRC staff disagrees with NextEra's numbers and comparison.

Both sides have a point. Cores strengths are 85-88% of cylinder strengths. But concrete does continue to gain strength in a moist service environment. And Mr. Sheik is correct this should be at least 20-25% if not more. The other aspect of this is that by 28 days after placement concrete will normally exceed its design strength by 20% or so.

Page 168
Compression strength discussion, need Paul to evaluate the rational.

Discussed above.

Page170
VISUAL EXAM CAN NOT RULE OUT PRESENCE OF ASR. It is the basis of Next Era's age management plan.

It can be problematic to understand why a crack is present merely by looking at it. Sometime you can tell, sometimes you can't. That's why petrography is routinely carried out

Page170
NextEra has not performed any tests to determine the rate of degradation, tensile stren gth, or bond strength in last 18 months.

Compression and splitting tensile tests on cores are routinely done. It is not expensive or exotic to do. It seems to me that this should be done on an ongoing basis as an aspect of conditional assessment.

Page170
You can not rule out ASR without petrographic examination. Paul, Is this correct?

I agree

Page171
ACRS committee asks for ASR data…GET DATE…DO FOIA

Page 174
Check the progress and status of ASR degradation by another acceleration test on the core samples, but NextEra does not intend to use test. Their consultant did include the test, NexEra said no. Paul, what is this test. Is it the best, are there others.

This is a mortar bar test. NextEra personnel likely wish to avoid carrying it outbecause it is their position that less expansion will occur in the on-site concrete because of the constraint of the reinforcing steel.

Page174
ASR cracks are active cracks. Industry standard is 15 millimeter width. Paul to

look at criteria for active cracks.

I agree with Mr. Sheik. Shrinkage cracks occur at the time of placement. If this crack displacement criterion is directed towards shrinkage cracks, it is misdirected in being applied to cracks induced by ASR

Page176
Discussion of crack width and acceptance criteria. NextEra interpreted the FHA. ACI-349 if crack width exceeds 15 mil you have to do a structural evaluation in tier2.

Page176
Standard is 0.5 millimeter crack width of 0.15 millimeter. According to NRC staff NextEra DOUBLED the value to crack width 1 millimeter instead of 0.1 millimeter

It seems clear that NextEra is pushing for an evalution based set of non-standard tests carried out at Univ of Texas vs using the ASTM standards.

It also seems clear that NextEra is looking for ways to minimize the regulatory impact associated with the formation of cracks in concrete that would generally be considered significant regardless of the deterioration mechanism causing them.

When concrete is in a compressive mode, a crack must be rather wide before the effect of aggregate interlock is lost. This is less true in a tensile or shear mode. However, a degradation mechanism, such as ASR, that leads to cracking has an autocatalytic aspect to it. In other words, the worse it gets, the worse it gets. This is because the cracks serve as high conductivity paths for the movement of water and aggressive species.