

Davis-Besse Shield Building Laminar Cracking

Licensee had extended discussions today with Professor Darwin.

Professor Darwin could not support an analytical determination of rebar splice strength in presence of a laminar crack. Basically, the licensee needs to identify sufficient uncracked zones at top of shield building so bond at rebar splices can be credited as effective.

Licensee plan going forward [1900 on 11/15/2011]:

- Lower portion of shield building – vertical rebar controls - seismic
- Upper portion of shield building – circumferential rebar controls – thermal loads
- Perform additional IR / core bore mapping at top of shield building to identify uncracked concrete areas
- Demonstrate effective circumferential rebar is adequate for design loads. This will be somewhat subjective since actual splice locations are not known and licensee has indicated rebar mapping is ineffective.
- New design basis calculations:
 - At bottom: make sensitivity calculation that removed rebar in shoulder regions a design basis calculation
 - At top: based on IR / core bore mapping, show that circumferential rebar connectivity is sufficient to demonstrate adequate load capacity for design loads

NRC technical reviewer challenges:

- Is licensee's proposed success path a viable solution
- How to define good concrete areas
- What portion of the shield building requires good concrete for sufficient bond strength at splices
 - Portion of splice in crack zone vs installed splice overlap length
 - Even though rebar splices are staggered, basis to credit load transfer of failed splice to adjacent rebar

NRC reviewers need to come to a consensus: is licensee's proposed success path a viable solution to identified circumferential cracking

D/22

Davis-Besse Shield Building Laminar Cracking

NRC would like licensee to provide outline defining Shield Building design calculation attributes:

Identified cracking:

- Cracking in flute shoulders
- Cracking outside flute shoulders near main steam line penetrations
- Cracking at top of shield building

Assumptions and engineering judgments used.

- Extent of cracking based on impulse response (IR) / core bore mapping
- Inability to identify exact location of rebar splices
- Load capacity of rebar in cracked concrete
- Other assumptions and engineering judgments used

Methodology

- Evaluation approach for above identified cracking locations
 - Load capacity of horizontal and vertical rebar
- Loads considered (dead load, thermal, seismic, other) or neglected at each cracking location
- Changes to method of evaluation used original design basis calculations
 - 50.59 evaluation needed?

Acceptance Criteria

- Derated load capacity of rebar in proximity to laminar cracking

Design basis compliance:

- Calculation in full compliance with original design codes and standards
- Exceptions to original design codes and standards
 - 50.59 evaluation needed?

Schedule:

NRC needs firm date for review of approved documents

Davis-Besse Shield Building Laminar Cracking

NRC questions for discussion related to licensee method of analysis:

1. If a rebar traverses through cracked and uncracked areas:
 - How much uncracked concrete in contact with the rebar on each side of the cracked area is required to credit the rebar as a capable load bearing component in the cracked area
 - What is basis for this requirement
2. In order to demonstrate that the shield building has sufficient areas of uncracked concrete to support the above requirement:
 - What percentage of shield building surface area must be validated to be uncracked
 - What is the basis or justification for this percentage
 - If another parameter is used to demonstrate areas of sufficient uncracked concrete, what is the parameter
 - What is the basis or justification for this parameter
3. How will your extent of shield building mapping demonstrate there is sufficient uncracked concrete in contact with rebar.
 - If entire shield building is not mapped, what is justification for extrapolating mapping data to unmapped areas
4. Please confirm that both circumferential and vertical rebar, if in a cracked region, are not considered in the strength evaluation
5. Please confirm that required rebar bond length will be based on the worst case design load combination demand
 - Paragraph 5.6.3.3 on page 24 of "investigation and Technical Summary" implies that normal loads [D+To] will be subtracted from maximum loading combination
 - $18.5 - 12.4 = 6.1$ ksi
 - Load to be developed into rebar should be 18.5 ksi [plus any load transferred from adjacent non-effective rebar]

**DAVIS-BESSE NUCLEAR POWER STATION
CONTAINMENT SHIELD BUILDING ISSUE
11/15/2011**

PURPOSE: To inform NRR senior management of situation at Davis-Besse with the Containment Shield Building cracks identified¹, and licensee response.

EXPECTED OUTCOMES: NRR management to understand the status of Davis-Besse's Containment Shield Building (SB).

PROCESS:

Background

While creating an access hole for Reactor Pressure Vessel head replacement, three issues were identified: (#1) Extensive cracking in the shoulder region, (#2) Cracking in the structural region outside the flute shoulder region near the main steam piping penetrations, (#3) Cracking indications via Impact Response (IR) mapping in the cylindrical portion of the building near the top of the building at the interface between the domed roof and the cylindrical wall. Items 2 and 3 are being evaluated separately. The licensee believes the cracks are limited to the shoulder region and do not extend into the region of the analyzed SB concrete. The licensee completed IR mapping and core boring determining that they had sufficient data for analysis.

Discussion

- On 11/12/11 tech staff from R3 and HQ had a teleconference to discuss licensee's responses to questions asked during the week of 11/7/11 and to determine what other questions needed to be answered.
- On 11/13/11 NRC tech staff and the licensee had a teleconference to present questions from the NRC and give the licensee a chance to clarify their previous responses.
- The NRC reiterated that a finalized report clearly explaining and documenting all the assumptions, calculations, and evaluation was expected before start up. The licensee provided many qualitative evaluations for the conditions, but the NRC requested quantitative justification.
- NRC asked to speak to the Professors used as references in the licensee's evaluation and to provide additional analysis for issue #3.
- Currently in Mode 5 and Mode 4 is scheduled for Sunday, Nov. 21, 2011.
- An internal conference between Region 3 and NRR tech staff was held on 11/14/11.
- A public meeting will be held on 11/16/11

Goals:

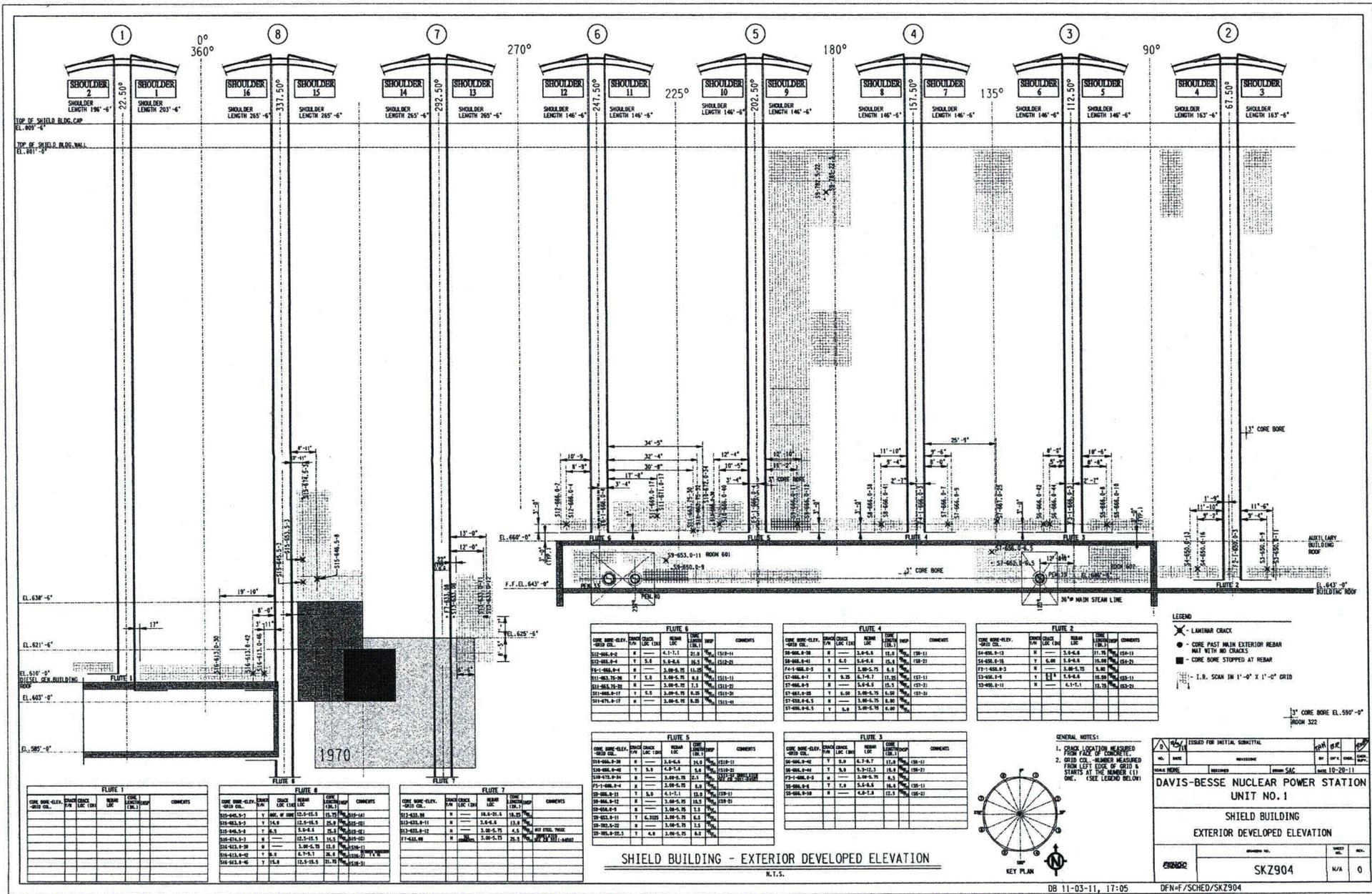
- Target is to decide about our technical basis today.
- A decision about the regulatory footprint also needs to be made, whether it is a corrective action letter (CAL), or public notification (PN) or other mechanism.

NRC Questions:

- What quantitative justification is there that the bond strength of the rebar does not need to be derated, or if it does need to be derated, that there was enough margin for safety in place to still meet the capacities in the FSAR?
- Has the licensee provided reasonable assurance that the SB will remain capable of performing its design function in the near and distant future (i.e. the condition will not worsen)? Why or why not?

¹ The issue is not similar to Crystal River. In the case of Davis-Besse, the concrete structure forms the containment building along with the steel liner. The steel containment is a separate structure approximately 5 feet inside the SB (see Picture 2 for a cross-section). There is actually an access area between the containment building and the SB. The SB functions as a portion of the Containment system and is Nuclear Safety-Related, Seismic Category 1, and serves 3 main purposes.

- During operations it provides shielding from radiation originating at the reactor vessel and the primary coolant loop
- During operation it provides environmental and tornado missile protection for the containment vessel
- Following a LOCA, the SB serves as a negative pressure boundary for the Emergency Ventilation System.



FLUTE 6					
CORE HOPE-CLY. GRID CO.	SHOULDER CRACK LRC	SHOULDER LRC	SHOULDER LRC	SHOULDER LRC	COMMENTS
S12-466.0-2	H	4.1-5.1	21.8	19.0	(130-1)
S12-466.0-3	T	5.0	5.0-5.6	16.5	(130-2)
S12-466.0-4	H	3.0-3.75	11.0	11.0	(130-3)
S11-466.0-1	T	5.0	5.0-5.75	6.0	(131-1)
S11-466.0-2	H	3.0-3.75	7.5	7.5	(131-2)
S11-466.0-3	T	5.0	5.0-5.75	6.0	(131-3)
S11-466.0-4	H	3.0-3.75	6.0	6.0	(131-4)

FLUTE 4					
CORE HOPE-CLY. GRID CO.	SHOULDER CRACK LRC	SHOULDER LRC	SHOULDER LRC	SHOULDER LRC	COMMENTS
S16-466.0-3	H	5.0-5.6	12.0	12.0	(130-1)
S16-466.0-4	T	5.0	5.0-5.6	15.0	(130-2)
S17-466.0-1	H	3.0-3.75	6.0	6.0	(131-1)
S17-466.0-2	T	5.0	5.0-5.75	12.0	(131-2)
S17-466.0-3	H	3.0-3.75	15.0	15.0	(131-3)
S17-466.0-4	T	5.0	5.0-5.75	6.0	(131-4)

FLUTE 2					
CORE HOPE-CLY. GRID CO.	SHOULDER CRACK LRC	SHOULDER LRC	SHOULDER LRC	SHOULDER LRC	COMMENTS
S4-466.0-1	H	3.0-4.0	11.75	10.0	(124-1)
S4-466.0-2	T	5.0	5.0-5.6	15.0	(124-2)
S7-466.0-1	H	3.0-3.75	6.0	6.0	(127-1)
S7-466.0-2	T	5.0	5.0-5.6	15.0	(127-2)
S7-466.0-3	H	3.0-3.75	15.0	15.0	(127-3)
S7-466.0-4	T	5.0	5.0-5.75	6.0	(127-4)

FLUTE 5					
CORE HOPE-CLY. GRID CO.	SHOULDER CRACK LRC	SHOULDER LRC	SHOULDER LRC	SHOULDER LRC	COMMENTS
S10-466.0-1	H	3.0-3.75	13.0	13.0	(132-1)
S10-466.0-2	T	5.0	5.0-5.75	16.0	(132-2)
S10-466.0-3	H	3.0-3.75	12.0	12.0	(132-3)
S10-466.0-4	T	5.0	5.0-5.75	6.0	(132-4)

FLUTE 3					
CORE HOPE-CLY. GRID CO.	SHOULDER CRACK LRC	SHOULDER LRC	SHOULDER LRC	SHOULDER LRC	COMMENTS
S6-466.0-1	T	5.0	4.7-4.7	11.0	(126-1)
S6-466.0-2	H	3.0-3.75	12.0	12.0	(126-2)
S6-466.0-3	T	5.0	5.0-5.75	6.0	(126-3)
S6-466.0-4	H	3.0-3.75	15.0	15.0	(126-4)

FLUTE 1					
CORE HOPE-CLY. GRID CO.	SHOULDER CRACK LRC	SHOULDER LRC	SHOULDER LRC	SHOULDER LRC	COMMENTS
S1-466.0-1	H	3.0-3.75	15.0	15.0	(121-1)
S1-466.0-2	T	5.0	5.0-5.75	12.0	(121-2)
S1-466.0-3	H	3.0-3.75	12.0	12.0	(121-3)
S1-466.0-4	T	5.0	5.0-5.75	6.0	(121-4)

FLUTE 8					
CORE HOPE-CLY. GRID CO.	SHOULDER CRACK LRC	SHOULDER LRC	SHOULDER LRC	SHOULDER LRC	COMMENTS
S15-466.0-1	H	3.0-3.75	15.0	15.0	(125-1)
S15-466.0-2	T	5.0	5.0-5.75	12.0	(125-2)
S15-466.0-3	H	3.0-3.75	12.0	12.0	(125-3)
S15-466.0-4	T	5.0	5.0-5.75	6.0	(125-4)

FLUTE 7					
CORE HOPE-CLY. GRID CO.	SHOULDER CRACK LRC	SHOULDER LRC	SHOULDER LRC	SHOULDER LRC	COMMENTS
S14-466.0-1	H	3.0-3.75	15.0	15.0	(125-1)
S14-466.0-2	T	5.0	5.0-5.75	12.0	(125-2)
S14-466.0-3	H	3.0-3.75	12.0	12.0	(125-3)
S14-466.0-4	T	5.0	5.0-5.75	6.0	(125-4)

- LEGEND**
- LAMINAR CRACK
 - CORE PAST WITH EXTERIOR REBAR MAT WITH NO CRACKS
 - CORE BORE STOPPED AT REBAR
 - I.R. SCAN IN 1'-0" X 1'-0" GRID

- GENERAL NOTES:**
1. CORE HOPE-CLY. MEASURED FROM FACE OF CONCRETE.
 2. GRID CO. NUMBER MEASURED FROM LEFT EDGE OF GRID & STARTS AT THE NUMBER (1) ONE. (SEE LEGEND BELOW)



ISSUED FOR INITIAL SUBMITTAL

DATE: 11-03-11

DESIGNED BY: [Signature]

CHECKED BY: [Signature]

DATE: 11-03-11

DAVIS-BESSE NUCLEAR POWER STATION UNIT NO. 1

SHIELD BUILDING

EXTERIOR DEVELOPED ELEVATION

PROJECT NO. SKZ904

DATE: 11-03-11

SCALE: N/A

REV: 0

SHIELD BUILDING - EXTERIOR DEVELOPED ELEVATION

N.T.S.

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Agenda for internal conference call 11-16-2011

- Summary of briefing with licensee 11-15-2011
- Items for discussion:
 - Problems with our last suggested approach
 - Licensee's revised approach – What is viability?
 - Re-status issues/building areas 1, 2, and 3. – Current thoughts on each.
 - Possible Order – can we prove not functional? What would this require?
 - Revisit fuel in the pot – Previously when this was discussed, the thinking was that T.S. only addressed the shield building (indirectly) with respect to needing it by Mode 4 and in addition at the time we had insufficient information to challenge the licensee's analysis (were early in the review) / what little we knew seemed small impact. Do we need to revisit that now that we know more?
 - Other?

10/25/2011 Conference Call Summary

Status Update

- The licensee has confirmed cracking in at least 5 of the 16 shoulders of the shield building through core bore samples and is currently brainstorming the methodology that will be used to assess this condition to ensure the shield building meets its design function.
 - The licensee will continue to perform Impulse Response (IR) mapping in all 8 flute regions and all 16 shoulders. The results of the IR mapping will be verified with core bore samples.
 - The cracking has not been bound by the core bores, therefore full extent of condition has not yet been determined.
 - Currently all cracks are limited to the shoulder region and do not extend into the region of the shield building considered in the structural analysis. The licensee believes that the ends of the architectural rebar is arresting the crack at those points, preventing growth beyond those points. (One possible exception just identified via IR mapping involves one region where the crack appears to extend beyond the shoulder. The licensee is evaluating.)
- In order to increase the areas accessible, the licensee will be using a "spider"/window washer type apparatus to extend IR mapping and core bores higher than the initial 30'.
- The licensee will be performing an evaluation that is expected to be available for NRC review on Monday, October 31st. Region 3 is requesting assistance from NRR in reviewing this evaluation. A quick turnaround is needed in order to define what the NRC position is prior to the licensee removing Mode 6 restraint tentatively scheduled on November 3 to permit reloading fuel into reactor vessel. Note that the November 3 date may slip.
- A root cause analysis is also being performed, apart from the evaluation.
- Though the licensee is still addressing the methodology to be used to perform the evaluation it is expected that it will involve finite element analysis and they will focus on two areas:
 - Demonstrating the rebar is unaffected. (Note that the cracks run along a line just outside of the outer structural rebar.)
 - Demonstrating that even by removing a portion of rebar by way of analysis, the shield building would still be able to meet its design function. Not clear yet how they would select rebar for removal in the analysis.
 - If their analyses are successful, their intent would be to not perform any actual repair.
- In order to eliminate confusion with the terms, new licensee definitions are being used by the licensee to describe the area that contains the cracks. Previously, it was described as a non-structural, architectural region. Currently, the entire building is being described as structural (since structural and architectural regions were part of the same pour in initial construction), with the exception that the shoulders were not considered in the structural analysis of the building. Therefore the cracks identified to date are still considered to be in a region that does not affect the analyzed portion of the building. (Note that the one

exception noted above with the cracking extending beyond the shoulder, the crack still appears to lie to the outside of the structural rebar. This is still being evaluated. Also, given its proximity to the cracking, note that the licensee needs to show as indicated above that the outer structural rebar is not impacted.)

- A SharePoint site will be created to facilitate document sharing between offices.

Tasks/Questions:

- Do we agree the licensee is adequately characterizing the conditions?
- The extent of concrete cracking has not been determined. Does the crack extend into the structurally evaluated portion of SB concrete?

NRC Position:

- There is currently limited data; therefore an NRC position has not been established pending the review of the evaluation when completed by the licensee and further internal discussions. Once we have enough information regarding extent of condition and safety impact, we will need to perform an M.D. 8.3 evaluation. There is no immediate safety concern because the plant is currently shutdown and defueled.

*Next Call scheduled for, Thursday, October 27 2:00pm CDT

10/27/2011 Conference Call Summary

Status Update

- The licensee is considering the anomalies found, where cracking was identified outside or beyond the shoulder region as a separate issue than the cracking identified within the shoulder region.
- Currently most of the identified cracking indications do not extend inside the outer extremity of the concrete rebar mat, both for the indications inside and outside the shoulder region.
- However, in at least one core bore, the crack extends slightly beyond the rebar concrete cover, but does not extend into the concrete between the interior rebar mat and the exterior rebar mat. [refer to SKZ904, Shield Building Exterior Developed Elevation, dated 10-28-11 @ 14:00; Flute 6 Core Bore S11-663.75-30: Crack identified at 5" from exterior surface; between rebar mat located 3" to 5.75" from exterior surface (3" concrete cover plus two 1.375" diameter rebar layers)]. The licensee is performing an analysis to demonstrate the rebar is unaffected. For defense in depth purposes the licensee will perform an additional calculation, removing some rebar from the analysis, with the intent of demonstrating that even without some of the rebar, the Shield Building would still be able to meet its design function.
- The root cause evaluation has not been completed; therefore, a conclusion in regards to the cause of the cracking has not been reached.
- The scope of IR mapping and core bores is being expanded to include areas that were previously inaccessible due to scaffolding limitations
- The extent and timeframe of the IR mapping and core boring activities is dependent on the results of the current activities.

Tasks/Questions:

- Do we agree the licensee is adequately characterizing the conditions?
- The extent of concrete cracking has not been determined. Does the crack extend into the structurally evaluated portion of SB concrete?
- Can the current condition worsen with time? How quickly?
- Do we agree with the extent of sampling being performed?

NRC Position:

- There is currently limited data; therefore an NRC position has not been established pending the review of the evaluation when completed by the licensee and further internal discussions. Once we have enough information regarding extent of condition and safety impact, we will need to perform an M.D. 8.3 evaluation. There is no immediate safety concern because the plant is currently shutdown and defueled.

*Next Call scheduled for, Wednesday, November 2nd 1:00pm CDT

Focus Team

- Region III
 - Dave Hills, DRS, Branch Chief, EB1
 - Jamnes Cameron, DRP, Branch Chief, Branch 6
 - Jim Neurauter, DRS, Senior Reactor Engineer, Structural Specialist
 - Jack Rutkowski, DRP, Project Engineer, Branch 6
 - Dan Kimble, Senior Resident Inspector, Davis Besse
 - Adam Wilson, Resident Inspector, Davis Besse
 - Elba Sanchez Santiago, DRS, Reactor Engineer, Regional POC
 - Viktoria Mityling, Senior Public Affairs Specialist
 - Prema Chandrathil, Public Affairs Specialist
 - Harral Logaras, Regional Government Liaison Officer
 - Allan Barker, Regional Government Liaison Officer

- Headquarters
 - Jacob Zimmerman, NRR, Branch Chief, DORL
 - Pete Hernandez, NRR, Project Manager, DORL
 - Marty Murphy, NRR, Branch Chief, DE
 - George Thomas, NRR, Structural Engineer, DE
 - Dan Hoang, NRR, Structural Engineer, DE
 - Ali Rezai, NRR, Materials Engineer, DE
 - Rajender Auluck, NRR, Branch Chief, DLR
 - Dennis Morey, NRR, Branch Chief, DLR
 - Bryce Lehman, NRR, Structural Engineer, DLR
 - Abdul Sheikh, NRR, Senior Structural Engineer, DLR
 - Samuel Cuadrado DeJesus, NRR, Project Manager, DLR
 - Russell Haskell, Reactor Systems Engineer, DIRS, IOEB

11/2/2011 Conference Call Summary

Status Update

- The licensee has identified cracking near the top of the building at the interface between the domed roof and the cylindrical wall. This is being considered a separate issue (3rd issue) and will be evaluated as such. The cracking in this region is located outside the shoulder region.
- The licensee solicited support from Bechtel to evaluate issue 3, and they are currently reviewing the dome to cylindrical wall design detail to explain the cracking identified in this area.
- For Issue #2 (2 anomalies identified outside the flute shoulder region in the structural region), the licensee performed core bores near main steam piping penetrations. The licensee is still evaluating this issue.
- The licensee has provided NRC two calculations addressing the cracking identified in the shoulder region. NRC's is currently reviewing the evaluations.
- Any questions stemming from the evaluation should be communicated to Jim Neurauter through email, for him to relay to the licensee. (please cc Elba Sanchez Santiago and Pete Hernandez on these e-mails for tracking purposes)

Additional Licensee Information for NRC review

- The licensee provided a technical assessment report related to cracking in the architectural flute shoulder area attached to CR 2011-03346 on 11/2/11.
- We are still expecting more evaluations that address the other issues identified. The licensee currently has planned to provide us with the following:
 - Technical Assessment Report Rev. 1 11/4/11
 - C-CSS-099.20-053 Rev. 0 – Nonlinear 3D Finite Element calculation 11/8/11
 - C-CSS-099.20-054 Rev. 1 – Evaluation of Shield Building with Outside Vertical Reinforcement Removed at Each Shoulder 11/9/11
 - Cracking Investigation and Assessment Report 11/4/11
- There are currently two Mode 6 holds in place awaiting clearance: One is associated with Shield Building Issue 2 (Cracking in the steam line penetration area), and one is associated with Shield Building Issue 3 (Cracking at the top of the shield building where the cylinder meets the dome). The licensee expects to complete the evaluations associated with these issues today in order to remove the mode 6 holds and commence refueling activities tomorrow.

Tasks/Questions:

- Do we agree the licensee is adequately characterizing the conditions?
- The extent of concrete cracking has not been determined. Does the crack extend into the structurally evaluated portion of SB concrete?
- Can the current condition worsen with time? How quickly?
- Do we agree with the extent of sampling being performed?
- Does the licensee have a justification on why the extent of sampling is adequate? Did they use a systematic approach when collecting the sample? If not, why do they not need to?

- Recommendations for regulatory actions and basis.

NRC Position:

- There is currently limited data; therefore an NRC position has not been established pending the review of the evaluation when completed by the licensee and further internal discussions. Once we have enough information regarding extent of condition and safety impact, we will need to perform an M.D. 8.3 evaluation. There is no immediate safety concern because the plant is currently shutdown and defueled.

*Next Call scheduled for, Friday, November 4nd 12:00pm CT