

**UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION**

**Before the Atomic Safety and Licensing Board**

In the Matter of	)	Docket No. 50-346-LR
First Energy Nuclear Operating Company	)	
(Davis-Besse Nuclear Power Station, Unit 1)	)	August 16, 2012
.	)	

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**INTERVENORS' FIFTH MOTION TO AMEND AND/OR SUPPLEMENT PROPOSED  
CONTENTION NO. 5 (SHIELD BUILDING CRACKING)**

*APPENDIX II: NRC FOIA RESPONSES (B-4 (PARTIAL)  
THROUGH B-23)*

### **Davis-Besse Shield Building Potential Cracking Issue**

On October 1<sup>st</sup>, 2011, Davis-Besse shut down for a planned maintenance outage to replace the reactor vessel closure head. The reactor vessel, which the reactor vessel closure head is bolted on top of, is located inside containment. The Davis-Besse containment system consists of a 1.5" free-standing, steel containment vessel surrounded by a 2.5' thick reinforced concrete shield building with a 4' annulus region in-between. In order to remove the old reactor vessel closure head and install the new one, workers needed to cut a 26'x36' hole, in the reinforced concrete shield building and the steel containment vessel. The method used for the removal of concrete to create the temporary construction opening was hydro-demolition.

On October 10, 2011, during hydro-demolition operations of the concrete at the outer layer of steel reinforcement on the shield building, an indication in the concrete was found. Potential fracture lines were identified at the bottom of the opening near the left corner (facing inward); at the top of the opening at the upper left corner, and at the left side of the opening a vertical indication along the inner layer of rebar was found. In order to characterize the indications found in the shield building the licensee consulted industry experts from Sargent and Lundy, and Bechtel. Per their expert opinion the indications found in the concrete were a product of the hydro-blasting operations and not a pre-existing condition. In order to verify this, in the case of the indications identified at the bottom of the opening and the left side of the opening, the licensee decided to excavate these areas using a small chipping device. The result of this excavation was that the indications did not extend into or around the concrete structure, causing the licensee to conclude there was no evidence of structural cracking in these areas. In the case of the indications identified at the top of the opening at the upper left corner, the licensee has decided to perform core borings to facilitate analysis in this area. This activity has not yet been completed.

The safety functions of the shield building are, during operation, to provide shielding from radiation originating at the reactor vessel and the primary coolant loop components and provide environmental and tornado missile protection for the containment vessel. The shield building also has a safety related function related to a postulated accident inside containment such as serving as a negative pressure boundary for the Emergency Ventilation System.

The discovery of these indications in the concrete of the shield building does not represent an immediate safety concern because the plant is currently shutdown and the reactor vessel is defueled. Currently, NRC inspectors are on-site reviewing the concern as part of the inspection activities associated with the oversight of the modifications in the plant for the replacement of the reactor vessel closure head. The NRC inspectors concur with the actions taken to date by the licensee and continue to evaluate the licensee's preliminary conclusions that the indications are related to the hydro-demolition and do not appear to be preexisting flaws in the concrete shield building.



Hernandez, Pete

**From:** Hernandez, Pete  
**Sent:** Friday, November 04, 2011 9:35 AM  
**To:** Sanchez Santiago, Elba  
**Cc:** Zimmerman, Jacob; Mahoney, Michael  
**Subject:** Questions about Davis Besse Shield Building Report from DORL

Elba, here are the questions I had about the report from Davis Besse. The calculations were a bit out of my range but, I had questions about their general methods. The Tech folk should have their questions over to you this morning also.

Thanks,

Pete

Questions about Davis Besse Shield Building Report

**C-CSS-099.20.054**

**Objective or Purpose (paragraph 3):** In this calculation the structural integrity of the SB is evaluated considering the presence of an interfacial/circumferential crack between the SB structural concrete shell (i.e., the 30" thick reinforced concrete SB) and each architectural flute shoulder (16 flute shoulders in total), as described in Attachment B.

This description makes me think that they are looking at a single crack going in a circle. From what I understood the crack is pervasive along the entire surface, spidering in all directions, similar to a pane of tempered glass breaking. The description in Attachment B addresses only the crack at the opening and assumes that the crack is right along the rebar line. The core bores have shown that the cracks are at different depths so this doesn't seem to capture the current situation. Throughout the calculation, the word Crack, singular, is used. They also mention that the extent of the crack is only 10'-12'. This seems to greatly downplay the issue.

**Scope of Calculation/Revision (bullet 4):** Maximum concrete crack width under flexure is calculated and compared with the allowable value (Section 7.5). Note that this maximum crack width evaluation only applies to the structural concrete (i.e., the 30" thick reinforced concrete SB shell). In particular, the width of any cracks in the 16 nonstructural architectural flute shoulders is not addressed.

At this point core bores of only the shoulders have been taken. So the only crack widths we are aware of are those in the shoulders, which are not being addressed. How can an analysis be done on the structurally credited concrete if no data from that area, in the form of core bores, has been taken? Shouldn't the structural integrity of the shoulders be calculated as well?

**Section 3.0 Methodology (last sentence):** Thus, this calculation focuses on the structural integrity of the reinforced concrete within and around the RCVH/SGs construction opening, once it is restored.

This seems to say that they are just doing calculations for the new concrete that is and ignores the rest of the building altogether. Is that right?

**Section 3.1 Construction sequence (page 6, second paragraph):** However, the vertical reinforcement next to each flute (i.e., in a vertical strip approximately 10 ft wide) is conservatively ignored for evaluating the structural integrity of the SB under mechanical loads... This says to me, that they are ignoring the shoulders, if they are ignoring all that concrete, it seems to be the opposite of conservative for evaluating the mechanical loads.

**C-CSS-099.20.055**

**Objective or Purpose:** The purpose of this calculation is to demonstrate that during a seismic event, with the development of the crack in the architectural flute shoulder, the capacity of rebar(s) can still provide adequate anchorage thus prevent cracked concrete piece from falling, and therefore Seismic II/I condition can be maintained.

I think the greater concern is will the SB stay standing and not whether or not the decorative concrete will fall off. Because the licensee has not performed core bores to see if there is cracking in the credited concrete, do they have a basis to say that the structural concrete will maintain a Seismic II/I condition?



This use of singular terminology also discounts this calculation because it seems that they are looking at only 1 crack and 1 shoulder or 1 flute. Because cracks have been found through multiple core bores, shouldn't the appropriate calculations account for the combined effects of cracks in all the shoulders and not just one by the opening and not just individually?

Section 6.2 (page 7): Based on Impulse Response testing, the actual crack length is 10 to 12 feet long.

From what I understand, IR mapping is only an indicator, but must be validated by core bores. Does basing all the calculations on a length of a 12 foot crack discount the calculations altogether, because we have indications of cracks at distances greater than 12 feet. This also seems to assume that there is only 1 crack and not many as the core bores seem to prove. Isn't IR mapping only useful at a limited depth too, so that using it to evaluate a 48" thick piece of concrete is not realistic?



Davis Besse Shield Building Issue  
NRC Technical Reviewer Focus Questions  
11/7/11

1. Does the licensee's extent of condition (scope of mapping and core bores) provide an acceptable systematic, representative sample that accurately characterizes the condition of the shield building (or at least sufficiently bounds the condition for analysis)? Why or why not?
2. Does the licensee's analysis provide reasonable assurance that the shield building will perform its design function? Why or why not?
  - a. If yes, does the shield building remain in conformance with all licensing and design basis requirements including required Codes and required safety margins? Note that if the shield building is functional but nonconforming, then the licensee would be able to restart the plant, but would be expected to have a plan in place to restore conformance (additional analysis, repairs, or license amendment) at the next reasonable opportunity.
3. Has the licensee provided reasonable assurance that the shield building 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? If not, are we comfortable until the next refuel outage (May 2012) and why, and what additional actions from the licensee, if any, do we think are necessary going forward?

Hernandez, Pete

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From: Hernandez, Pete  
Sent: Wednesday, November 09, 2011 11:26 AM  
To: Auluck, Rajender; CuadradoDeJesus, Samuel; Gonzalez, Hipolito; Haskell, Russell; Hernandez, Pete; Hoang, Dan; Lehman, Bryce; Lupold, Timothy; Mahoney, Michael; Miller, Barry; Morey, Dennis; Murphy, Martin; Nolan, Ryan; Rezai, Ali; Rihm, Roger; Sanchez Santiago, Elba; Sheikh, Abdul; Snyder, Amy; Thomas, George; Thorp, John; Wiebe, Joel; Zimmerman, Jacob  
Cc: DiFrancesco, Nicholas  
Subject: Re: Davis Besse Sheild Building teleconference

Good morning everyone,

As you may have heard, if we were to join the conference call today from OWFN, it would more than likely be interrupted. As a solution, Jake Zimmerman, Dan Hoang and I are going to the RES building on the 1:30 pm shuttle to borrow an office, 5A02 (thanks to Pat Hiland for getting that for us). You are welcome to join us. I suggest meeting down by the shuttle at ~1:20pm. After that the next shuttle is 1:50 and 2:10.

To clarify, the purpose of teleconference is for the licensee to give the presentation. We should ask clarification questions about the slides but the region still plans on formally submitting technical questions to the licensee on Thursday, November 10, 2011. So in-depth technical questions from NRC staff should be sent to me to consolidate and then send to the region to be reviewed by regional tech staff and formally submitted to the licensee. Though the licensee wants to button up this issue and plans to go to Mode 4 on Nov. 18<sup>th</sup>, please review the evaluations as thoroughly as possible.

Thanks,

Pete Hernandez



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**Craver, Patti**

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**From:** Zimmerman, Jacob *MRK*  
**Sent:** Friday, November 11, 2011 7:52 AM  
**To:** Evans, Michele  
**Cc:** Howe, Allen  
**Subject:** Re: DB shield building

Thanks Michele for reaching out to your counterparts. It's good to hear Region 3 management is engaged and aligned.

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**From:** Evans, Michele *MRK*  
**To:** Zimmerman, Jacob  
**Cc:** Howe, Allen  
**Sent:** Thu Nov 10 18:34:16 2011  
**Subject:** DB shield building

Jake,

I spoke to Pat Hiland and Marty Murphy today and later Steve Reynolds. Based on my discussion with Steve, Region III management is very tied into the situation and intends to maintain the lead for this issue. NRR's role is to provide technical advice.

Pete and Nick stopped by after today's call and updated Louise and me. We authorized them to work OT (Saturday) to listen into that call.

*Michele*

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Discussion points relayed to the licensee after our internal technical discussion 11-12-2011

1. Related to SB-42
  - a. Compilation of calculations, testing, etc. related to S.B. cracking into a clear and concise report that addressed NRC 3 technical focus questions SB 25, 26, 27
  - b. Current 12/12/11 completion as part of CR-2011-3346 is not acceptable for justification for earlier startup.
  - c. NRC needs this clear and concise report with sufficient time for review prior to startup.
2. Request Professors Sozen and Darwin presence on NRC call tomorrow; if unavailable tomorrow, request licensee establish call between the professors and the NRC as early as Monday.
3. Technical concern
  - a. ACI 349.3R not applicable to laminar cracking
  - b. 360° laminar crack does not address Prof. Darwin's concern that circumferential steel be located outside crack region to support the conclusion that "no mode change or operating restrictions" are required.
    - i. Were the professors aware of the 360° postulated laminar cracking in upper shield building?
    - ii. Appear Prof. Darwin stipulates cracking to be outside spliced region.
4. Technical Notes:
  - a. Top of shield building - 360° around 20' down from the top
    - i. Challenges Prof. Darwin concern that rebar splices be outside cracked region
    - ii. No ACI standard for evaluation and no licensee structural evaluation
  - b. Concern that sampling did not eliminate I.F. cracking at top of SB (different undefined failure mechanism Then in the shoulder)
  - c. Outside shoulder area at top, what is the technical explanation of why the cracking is limited to the outer rebar mat and does not extend through the rebar mat thickness.
  - d. Any splice in cracked regions require further evaluation – Prof. Darwin
    - i. Design calc – fully effective rebar, unverified assumption (ACI 349.3R not applicable to laminar cracking)

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Hernandez, Pete

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From: Hernandez, Pete  
Sent: Tuesday, November 15, 2011 12:25 PM  
To: Zimmerman, Jacob  
Subject: Draft email

Good afternoon,

A follow-up internal call was held this morning at 11am with staff from Region 3 and NRR regarding the Davis Besse Shield building. We are waiting on the following 4 items from the licensee:

- Literature and documented studies about bonding between concrete and rebar (on the Sunday, 11/13 call licensee promised us these)
- Availability of Professor Darwin to discuss his peer review (licensee indicated he would not be available until Thursday, 11/17)
- Splice evaluation for NRC review (this evaluation is underway)
- Summary document detailing their assumptions and engineering basis of how they still meet the design basis specifications (licensee has stated that this will be provided this afternoon or evening).

The licensee requested a delay of the public meeting to give them more time to finish the splice evaluation. The NRC accepted so that we would have time to review the documents before the meeting.

Thanks,

Pete

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**Hernandez, Pete**

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**From:** Hernandez, Pete *mmk*  
**Sent:** Tuesday, November 15, 2011 12:36 PM  
**To:** Evans, Michele; Howe, Allen; Lund, Louise  
**Cc:** Zimmerman, Jacob  
**Subject:** RE: Updated Davis-Besse Containment Shield Building POP

Hi Michele,

It is being postponed until Thursday (the time is not set yet) so that the licensee has more time to finish their calculations of the rebar splices and so that we can review them beforehand. It was at the licensee's request that it was changed. Let me know if you need more details.

Thanks,

Pete

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**From:** Evans, Michele *mmk*  
**Sent:** Tuesday, November 15, 2011 12:22 PM  
**To:** Hernandez, Pete; Howe, Allen; Lund, Louise  
**Cc:** Zimmerman, Jacob  
**Subject:** RE: Updated Davis-Besse Containment Shield Building POP

I just heard that the meeting is cancelled for tomorrow. That is per Abdul in the elevator 5 minutes ago.

Jake or Pete - Do you guys have any insight as to why cancelled?

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**From:** Hernandez, Pete  
**Sent:** Tuesday, November 15, 2011 10:39 AM  
**To:** Evans, Michele; Howe, Allen; Lund, Louise  
**Cc:** Zimmerman, Jacob  
**Subject:** Updated Davis-Besse Containment Shield Building POP

Note that a public meeting will be held tomorrow afternoon from 2pm – 6pm (eastern) in Region 3.



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**From:** Hernandez, Pete  
**To:** Auluck, Rajender; CuadradoDeJesus, Samuel; Gonzalez, Hipolito; Haskell, Russell; Hills, David; Hoang, Dan; Lehman, Bryce; Lupold, Timothy; Mahoney, Michael; Miller, Barry; Morey, Dennis; Murphy, Martin; Nolan, Ryan; Rezai, Ali; Rihm, Roger; Sanchez Santiago, Elba; Sheikh, Abdul; Snyder, Amy; Thomas, George; Thorp, John; Wiebe, Joel; Zimmerman, Jacob; Graves, Herman; Pires, Jose; Jessup, William; Riley (OCA), Timothy  
**Subject:** Davis Besse conf call  
**Start:** Wednesday, November 16, 2011 10:00:00 AM  
**End:** Wednesday, November 16, 2011 5:00:00 PM  
**Location:** HQ-OWFN-09B02-12p

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When: Wednesday, November 16, 2011 10:00 AM-5:00 PM (GMT-05:00) Eastern Time (US & Canada).  
Where: HQ-OWFN-09B02-12p

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

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Good morning yall,

I've reserved O-9B2 for the rest of the day so we can call from there.

Thanks,

Pete

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Hernandez, Pete

UNITED STATES

NUCLEAR REGULATORY COMMISSION



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Hernandez, Pete WASHINGTON, D.C. 20555-0001  
Thursday, November 17, 2011 7:58 AM  
Sanchez Santiago, Elba  
Davis Besse Operability question

Good afternoon Michele,

I understand that the question of Operability vs design basis was posed, and that if <sup>the SB</sup> ~~this~~ <sup>is</sup> ~~was~~ in operations space, are qualitative evaluations the extent of review required by the licensee?

To answer that, the distinction between Operability and Functionality needs to be understood. The most clear way I've had it explained is that the determination of Operability is tied to the Tech Specs for the specific plant. If the Tech Specs are met, then it is operable. (An operability determination is usually prompted by degraded conditions, nonconforming conditions or the discovery of an unanalyzed condition.) Functionality is tied to the design bases documented in the FSAR and thereby tied to the Current Licensing Basis.

From IMC9900

"If an SSC described in TSs is determined to be operable even though a degraded or nonconforming condition is present, the SSC is considered "operable but degraded or nonconforming." An SSC that is determined to be operable but degraded or nonconforming is considered to be in compliance with its TS LCO, and the operability determination is the basis for continued operation. The basis for continued operation should be frequently and regularly reviewed until corrective actions are successfully completed."

The licensee decided to not enter into an Operable but Degraded or Nonconforming determination and that the cracking issue is a design basis question hence functionality.

Speculating: The cracks in the building qualify as an unanalyzed condition so for the licensee to Operate with a degraded or nonconforming condition, they would have to develop a plan to fix the issue through their CA process. However, the licensee has stated that the SB is Operable as is, so there is nothing to fix. This still leaves the issue of the cracks unresolved so they are trying to prove that the cracks do not affect the functionality of the building. This led them to the design basis evaluations.

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**Davis-Besse Containment System**  
**Primary Steel Containment and Shield Building**  
**November 17, 2011**

**References:**

Davis-Besse USAR Section 1.2.10, "Containment Systems"

Davis-Besse TS 3.6.1, "Containment"

Davis-Besse TS 3.7.12, "Station Emergency Ventilation System"

**Description:**

As described in the USAR, the "containment . . . consists of two structures: a steel containment vessel and a reinforced concrete shield building, and their associated systems." The steel containment vessel is 2.5 inches thick on the sides and provides a large volume to contain the energy released from a loss-of-coolant accident (and steam line breaks, etc. inside containment). The design internal pressure is 40 psig. This steel structure also must meet 10 CFR Part 50, Appendix J, "Leakage Testing" requirements to limit the release of radionuclides that might exist outside of the reactor system after an accident to a very small percentage of the total volume of the steel vessel.

The shield building is reinforced concrete structure, with a 2.5 feet thick side thickness, that surrounds the steel vessel. There is an approximate distance of 4.5 feet between the shield building internal surface and the steel containment vessel. The shield building "shields" the steel vessel from environmental conditions (rain, snow, wind, etc) including tornado forces and any missiles that might be generated by high wind conditions or turbine failures. The volume between the two structures also provides a path for ventilation (the Emergency Ventilation System) to sweep any radionuclides that might leak from the steel vessel, post-accident, into an Engineered Safety System that can filter (HEPAs and Charcoal) the swept air/leakage before release through a ventilation stack to the environment. This "sweeping and filtering" is utilized to limit exposure to the public, from a hypothetical accident, to below 10 CFR Part 100 guidelines. The shield building also helps reduce the radiation field that might exist, outside of the structures, because of conditions inside the steel containment vessel. The shield building was designed to withstand forces generated by design bases seismic events in addition to forces from temperature changes, etc.

TS 3.6.1 requires that the Containment be operable in Modes 1 through 4. For the primary vessel this requires meeting the leakage limitations and having required valve isolation capability. For the shield building this specification requires periodic visual examination of the surfaces (internal and exterior) of the shield building.

TS 3.7.12 requires that the Emergency Ventilation System, which includes the space between the shield building and the steel vessel, be operable in Modes 1 through 4 (anything greater than 200 degrees F in the reactor coolant system). The Emergency Ventilation System, as part of that specification, must be capable of maintaining a slight negative pressure, relative to existing atmospheric pressure, within the space between the shield building and the steel vessel. This is to ensure that anything leaking, post-accident, from the steel vessel, is swept and filtered prior to release to the environment.

The existing as-found condition of cracking in the concrete of the shield building has raised questions on the ability of the structure to maintain its ability to perform its design functions under conditions that would introduce active forces in the structure (such as a seismic event or potentially rapid changes in environmental conditions).

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