FENOC™
FirstEnergy Nuclear Operating Company

5501 North State Route 2
Oak Harbor, Ohio 43449

Raymond A. Lieb
Vice President, Nuclear

419-321-7676
Fax: 419-321-7582

February 28, 2013
L-13-098

10 CFR 54

ATTN: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT:
Davis-Besse Nuclear Power Station, Unit No. 1
Docket No. 50-346, License Number NPF-3
Revised Reply to Request for Additional Information for the Review of the Davis-Besse Nuclear Power Station, Unit No. 1, License Renewal Application (TAC No. ME4640)

By letter dated August 27, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102450565), FirstEnergy Nuclear Operating Company (FENOC) submitted an application pursuant to Title 10 of the *Code of Federal Regulations*, Part 54 for renewal of Operating License NPF-3 for the Davis-Besse Nuclear Power Station, Unit No. 1 (Davis-Besse). By letter L-13-037 dated February 12, 2013, FENOC replied to Nuclear Regulatory Commission (NRC) requests for additional information (RAIs) related to NRC review of the Davis-Besse License Renewal Application (LRA). During a telephone conference with the NRC Project Manager for Davis-Besse License Renewal held on February 19, 2013, the NRC stated that it appeared there was a typographical error in the FENOC response to RAI B.2.43-2a regarding the value for university testing crack size.

FENOC performed a review of the response to RAI B.2.43-2a and confirmed that the university testing crack size of 0.20 inches provided in the response was a typographical error. The correct value for the crack size should have been 0.020 inches. FENOC performed a review of the entire response and identified one additional change in the response. Specifically, in the fourth paragraph of the response, the statement that "[t]wo adjacent splices at 6 inches on center spacing were used" should read "[t]wo adjacent splices at clear spacing of approximately 6 inches were used", since the spacing between the splices was not "on center" spacing. These conditions were entered into the FENOC Corrective Action Program.

The Attachment provides the revised FENOC reply to NRC request for additional information B.2.43-2a. The NRC request is shown in bold text followed by the FENOC response.

A145
NRR

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Clifford I. Custer, Fleet License Renewal Project Manager, at 724-682-7139.

I declare under penalty of perjury that the foregoing is true and correct. Executed on February 28, 2013.

Sincerely,

Raymond A. Lieb

Attachment:

Revised Reply to Request for Additional Information for the Review of the Davis-Besse Nuclear Power Station, Unit No. 1 (Davis-Besse), License Renewal Application (LRA), Section B.2.43

cc: NRC DLR Project Manager
NRC Region III Administrator

cc: w/o Attachment
NRC DLR Director
NRR DORL Project Manager
NRC Resident Inspector
Utility Radiological Safety Board

Question RAI B.2.43-2a

Background:

By letter dated November 20, 2012, the applicant responded to a request for additional information (RAI) regarding the proposed monitoring methods for the shield building (SB) cracking. The RAI response indicates that the proposed inspection sample size of 20 core bores will cover the three areas of cracking (flute shoulders, upper 20 ft of the building, and the steam line penetrations) and is adequate to identify any changes in the laminar cracking, without further impulse response testing during the period of extended operation.

Issue:

As part of evaluating the applicant's plan for monitoring the SB cracking with core bores, the staff needs to understand the technical basis for the size of the sample. For example, is the sample based purely on statistics or is it based on the long term effect of the concrete cracks on the ability of the reinforcement to carry design loads and the safety significance of the cracking. In an earlier RAI response, dated April 5, 2012, it was indicated that the structural impact of the cracking would be determined via testing. A summary description of the test results and discussion of how the test results demonstrate that the sample size is sufficient has not been provided.

Request:

Provide a discussion of the technical basis for the adequacy of the sample size. If the sample size was based on laboratory testing, provide a summary of the testing. Include an explanation of the testing completed as well as the results, and how this information relates to the structural capacity of the SB and supports the adequacy of the sample size.

Telephone Conference Call Summary:

The NRC Staff initiated a telephone conference call with FENOC on January 16, 2013, to discuss and clarify NRC follow-up RAIs B.2.43-2a and B.2.43-3a regarding the Davis-Besse Shield Building Monitoring Program. Following discussions, NRC Staff stated that, instead of addressing RAI B.2.43-2a as written, FENOC should respond to the RAI by providing summaries of the laboratory (i.e., university) testing performed and the results of the testing. The summary should address the

Shield Building reinforcing bar-concrete bond strength, the assumptions made in the structural operability calculations regarding bond strength, and how the testing performed supports those assumptions. A copy of laboratory reports is not needed by the NRC Staff.

RESPONSE RAI B.2.43-2a

Testing was performed at the University of Kansas and at Purdue University to assess the concrete-rebar bond strength of concrete with a laminar crack. Given the conservative nature of the test conditions used in these studies, it is concluded that the reinforcement in the Shield Building experiences little, if any reduction in strength and capacity due to the laminar cracking condition.

During the evaluation of the Shield Building laminar cracking in 2011, FENOC performed calculations to document that the Shield Building remains capable of performing its safety functions despite the presence of laminar cracking. FENOC assumed in the evaluation calculations that there was no reinforcement capacity in cracked zones where the reinforcing bar included splices. The rationale for the assumption was that unspliced rebar spanning cracked zones retained capacity, while reinforcement capacity with rebar splices could not be quantified, and therefore was considered ineffective in the analysis. It was recognized at the time that follow-up laboratory testing was required to confirm assumptions regarding reinforcement capacity of spliced rebar.

FENOC sponsored independent testing programs at Purdue University and the University of Kansas to determine the effects of laminar cracking in the plane of and parallel with reinforcing bar splices (a condition similar to the Shield Building laminar cracking). The laboratory testing confirmed that the robust design and construction of the Shield Building allow the building to retain significant margin against design loads even with laminar cracking.

Both universities conducted testing programs to evaluate the effects of the laminar cracking using large scale rectangular section beams with size #11 tension reinforcement splices. The #11 reinforcement was chosen since it matches the size used in the construction of the Shield Building. Two adjacent splices at clear spacing of approximately 6 inches were used in all beams to simulate rebar interaction. The test specimen set-up at both universities was conservative since the Shield Building reinforcement splices are staggered, and not side-by-side, as constructed at both laboratory test facilities. Both testing programs used materials that were representative of the Shield Building materials with similar strengths. Concrete strengths of the samples were representative and conservative relative to the strength of the materials in the Shield Building. Select beams in both the Purdue and Kansas studies were subject to reload cycles. These beams were loaded to develop the crack (at calculated yield), unloaded, and the beams were reloaded to failure. The crack sizes developed exceeded the crack widths identified in the Shield Building.

Purdue University tested six samples with 120-inch splices and six samples with 79-inch splices. These splice lengths correspond to the splice lengths used in the Shield Building. Purdue used beam geometry in order to produce a preferential (laminar) crack at the location of reinforcement when loaded.

During testing, cracks developed and opened to widths exceeding 0.10 inches when approaching the maximum load. These crack widths well exceeded the Shield Building cracks identified and essentially covered the entire test span prior to failure.

Each of the beams tested demonstrated two fundamental properties:

1. Each beam developed yielding stress in the reinforcement after the development of laminar cracks, and

2. The load deflection curves for each beam exhibited classic ductile behavior with increasing deflection beyond the yield point.

These tests demonstrate that the reinforcement, and therefore the building as a system, retains its strength despite cracking, given the reinforcement was capable of developing yield stress. By exhibiting ductile behavior, the tests confirm that despite the laminar cracking condition, the building system can be expected to demonstrate the classically required deflection and surface cracking indications prior to failure.

The University of Kansas also used a large-scale rectangular beam section with #11 rebar splices as noted above; however, the main study beams were cast with a cold joint in the plane of the reinforcement for a length greater than the entire splice length. The University of Kansas tested 6 beams: 3 with 79-inch splices, and 3 with 120-inch splices. These splice lengths correspond to the splice lengths used in the Shield Building.

For the beams with the reload cycles, crack widths were at or greater than a width of 0.020 inches prior to unloading. This exceeds the crack widths identified in the Shield Building by a factor of approximately 2. These specimens developed capacities near and above yield despite the conservative testing conditions.

Given the conservative nature of the conditions used in the tests, it is the conclusion of the professors who conducted and evaluated the tests that the reinforcement in the Shield Building experiences little, if any, reduction in strength and capacity due to the laminar cracking condition. The studies also document that the structure retains its serviceability and ductile behavior. The university test findings provide additional confidence in structural adequacy above that already documented in the functionality calculations, and confirmed that the robust design and construction of the Shield Building allow the building to retain significant margin against design loads even with laminar cracking.