FENOC

FirstEnergy Nuclear Operating Company

Davis-Besse Nuclear Power Station
5501 N. State Route 2
Oak Harbor, Ohio 43449

October 28, 2014
L-14-354

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
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 dated September 29, 2014 (ML14258A285), the Nuclear Regulatory Commission (NRC) requested additional information to complete its review of the License Renewal Application (LRA).

The Attachment provides the FENOC reply to the NRC request for additional information. The NRC request is shown in bold text followed by the FENOC response.

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 October 28, 2014.

Sincerely,

Thomas J. Summers
Director, Site Operations

Attachment:
Reply to Requests 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.2.43-5 (follow-up)

Background:

FENOC's response to RAI B.2.43-4 by letter dated July 3, 2014 (ADAMS Accession No. ML14184B184), states in part:

> **Due to the plant-specific operating experience described in the request, above, the minimum number of Shield Building monitoring bores currently managed under the FENOC Corrective Action Program is being changed to 23. Three monitoring bores will be used to aid in identifying changes in the limits of cracking in areas with previously identified crack propagation. New core bores will be installed as required during each inspection cycle to bound crack limits.**

The "Operating Experience" program element of LRA Section B.2.43, "Shield Building Monitoring Program," revised by letter dated July 3, 2014 in response to RAI B.2.43-4, states in part, "This re-inspection also identified 8 conditions where the laminar cracking conditions were determined to have undergone a discernable change."

Issue:

In response to RAI B.2.43-4, the basis or criteria for selecting three (3) of the eight (8) core bore holes, with discernable change in laminar cracking conditions, in the sample for subsequent consecutive inspections was not fully or clearly described.

Request:

1) **Provide additional discussion and detail on the technical rationale or criteria used to justify the selection of additional core bore holes for future examination.**

2) **Provide, with the basis, the minimum number and/or time period of subsequent consecutive inspections for which core bore holes with identified crack propagation will be inspected following discovery before they may be removed from the representative sample. The response should include a discussion of the consideration, if any, given the core bore hole inspection**

intervals and the schedule proposed in the Shield Building Monitoring Program.

RESPONSE RAI B.2.3-5 (follow-up)

1) The selection of additional core bores for future examination of the cracking identified within the Davis-Besse Shield Building will be based on the extent and direction of propagation of laminar cracking in the structure. FirstEnergy Nuclear Operating Company (FENOC) currently knows the size and extent of the original pre-existing sub-surface crack, and the cause and rate of crack propagation due to ice-wedging. FENOC is monitoring the crack size, shape and progression by use of 23 strategically-selected core bores, 3 of which were chosen to monitor the leading edge of crack propagation; these 23 bores are representative of the remaining cracked areas. If crack planar propagation passes completely through 1 of the 3 leading edge core bores, then a new leading edge core bore will be added adjacent to that bore to maintain at least 3 leading edge monitoring bores.

   The condition of cracking identified within the Davis-Besse Shield Building is a phenomenon of laminar cracking oriented in the plane of the outside face rebar for the Shield Building, caused by a single event in 1978. Crack perimeters were identified to be slowly expanding or propagating during routine long term monitoring inspections in 2013. This propagation was identified within areas overlaid by the building architectural shoulders. It has been determined through causal analysis that the crack propagation is a result of "ice wedging". Concrete crack growth by ice wedging, by definition, requires a previously existing crack, the presence of water and a freezing cycle, resulting in the extension of the crack.

   The entire shield building was mapped with Impulse Response Testing and validated by over 80 core bores in 2011-12. Therefore, the location of the pre-existing sub-surface crack is understood. During the 2013 monitoring of core bores for the Shield Building laminar cracking condition, "new" cracking was identified in 8 bores. As part of the extent of condition investigation, FENOC conducted informational Impulse Response mapping at 5 locations (approximately 2200 square feet) for overall perimeter identification, and examined all 80 existing bore locations.

   The discovery of changes in the condition of the structure validates that visual bore monitoring is an effective means of identifying changes in the structure. In order to understand the changes, the features of the 8 bores with changes were assessed and divided into two categories. The first category (Category 1) is where the leading edge of an existing crack propagated into previously un-cracked concrete (perimeter expansion – 5 bores). The second category (Category 2) is where changes were identified in a previously cracked bore where planar propagation was not identified (3 bores). A crack offshoot developing in a bore is representative of the changes identified in these 3 locations.

Following analysis of the 5 Category 1 bores, it was identified that 2 bores are already within the population of the originally proposed 20 bores selected for long term monitoring under the Shield Building Monitoring Program. Therefore the remaining 3 bores are added to the program for monitoring.

Category 2 bores were not incorporated into the monitoring program since they do not provide information related to identifying the leading edge (perimeter) of the crack. The existing monitoring program includes a population of bores within the area of cracking such that determination of changes to the cracked condition can be identified.

Of the 23 bores identified for long term monitoring, a subset of 3 locations where the crack perimeter has been determined to be expanding will also be monitored such that planar limits of the crack are monitored and bounded. This selection of 3 locations is representative of the 5 Category 1 bores with considerations to the fact that 2 of the 5 bores intersect the same leading edge (bores are drilled at approximately the same elevation, approx. 2' horizontally offset from each other), as well as personnel safety access limitations for 1 bore near the start-up transformer.

The aging management program will now routinely examine 23 bores at various locations around the structure. The visual inspection method has proven to be effective at identifying small changes in the laminar cracking, and the population of 20 bores for monitoring at various elevations is representative of the initial event-driven laminar cracking condition. The addition of the 3 bores for ongoing monitoring at the leading edge of planar propagation combined with the 20 existing monitoring bores is adequate to track and manage the propagation phenomenon, and is representative of the remaining cracked areas. If crack planar propagation passes completely through any of the 3 leading edge core bores, then a new leading edge core bore will be added adjacent to that bore to maintain at least 3 leading edge monitoring bores.

2) There is no minimum number and/or time period of subsequent consecutive inspections for which core bore holes with identified crack propagation will be inspected following discovery before they may be removed from the representative sample. FENOC intends to perform inspections of the 23 monitoring bores throughout the period of extended operation. A bore hole added to the inspection scope for the purposes of monitoring laminar cracking limits would be removed from scope if it has been cracked 360 degrees around and can no longer bound cracking limits. Prior to removal from the scope of inspection, a new leading edge core bore would be installed adjacent to the bore being removed in order to maintain the population of 3 leading edge core bores for monitoring crack propagation.

Based on the FENOC response to NRC requests for additional information (RAIs) on Shield Building cracking submitted by letter dated July 3, 2014 (ADAMS Accession Number ML14184B184), the frequency of internal visual inspection for the 23 monitoring bores is annual inspections for a minimum of 4 years starting in 2015. For the Shield Building Monitoring Program, following acceptable results of the one-year interval inspections, the interval will be changed to a two-year interval in 2019, to a maximum four-year interval after the 2026 inspections. These inspection intervals will be evaluated for effectiveness by the Shield Building Monitoring Program. Should there be an identified change to the cause of the condition, significant change to the rate of crack growth, or a condition adverse to the bounding nature of the design basis documentation, modifications to the Shield Building Monitoring Program will be determined using the FENOC Corrective Action Program.

As noted in the Shield Building Monitoring Program, Sections 2.4.b and 2.6.b, bore holes are examined for changes in crack width. Therefore, even if a bore hole is cracked 360 degrees around and no longer able to define planar limits, any previously identified changes to width will have been entered into the Corrective Action Program, and that information will be used in the decision-making process to determine whether changes are required to the inspection schedule (e.g., increase inspection frequency) or parameters monitored (e.g., increase the number of core bores monitored).

Question RAI B.2.43-6 (follow-up)

<u>Background</u>:

LRA Section B.2.43, updated by letters dated November 20, 2012 and July 3, 2014, describes the plant-specific Shield Building Monitoring Program. This aging management program (AMP) includes under its scope the steel reinforcement bar (rebar) and concrete of the shield building wall and the exterior concrete coatings on the shield building. The "Program Description" and program element "Parameters Monitored or Inspected" state that the program will monitor rebar for loss of material due to corrosion by visual inspection of the surface condition of rebar, when exposed.

The "Operating Experience" program element of LRA Section B.2.43, revised by RAI B.2.43-4 response letter dated July 3, 2014 (ADAMS Accession No. ML14184B184), identified conditions involving propagation of the shield building laminar cracks during a 2013 baseline inspection, and states in part that:

> **This re-inspection also identified 8 conditions where the laminar cracking conditions were determined to have undergone a discernable change.**
>
> **The cracking propagation was determined to be a result of ice-wedging (freezing water at a pre-existing crack leading edge). This condition requires water, freezing temperatures and pre-existing cracks. Because the Shield Building has been coated it contains a finite amount of water. It is not practical to remove the water in an accelerated manner given the cumulative magnitude of leading crack edges and transportability of water. It is also not practical to remove the existing cracks or prevent freezing temperatures.**

The response to RAI B.2.43-4 did not identify any changes to the Shield Building Monitoring Program with regard to monitoring of the rebar for corrosion but documented operating experience of the presence of water within the pre-existing cracks which under freezing temperatures may cause the cracks to propagate.

Issue:

The Shield Building Monitoring Program monitors rebar for corrosion by visual inspection, on an opportunistic basis, only when exposed for some undefined reason. The presence of water and air trapped within the existing potentially propagating laminar cracks of the coated shield building wall increases the potential for corrosion of the adjacent rebar layers. The staff also noted in LRA Section 3.5.2.2.1.1 that the groundwater chemistry at the Davis-Besse site is considered to be aggressive (i.e., chlorides = 2,870 ppm (max) and sulfates = 1,700 ppm (max)) which may also be indicative that the shield building is or has been exposed to potentially aggressive (high chloride content) air-outdoor environment that favors potential for rebar corrosion. Given the above plant-specific conditions and operating experience, the staff needs additional technical justification and basis regarding the AMP's implementation of opportunistic inspections to monitor aging effects in the rebar located near the laminar cracking.

Request:

Considering the plant-specific conditions of the shield building wall associated with existing laminar cracking that may propagate; presence of trapped water and air in the laminar cracks; and potentially aggressive environmental conditions; explain, with sufficient technical detail and basis, the following:

1) **How opportunistic inspection of rebar when exposed will adequately manage potential aging effects of rebar corrosion for rebar layers located near laminar cracking, or**

2) **Any modifications or enhancements that will be made to the Shield Building Monitoring Program or any other applicable AMP to address the staff's concern regarding the implementation of opportunistic inspection of rebar when exposed to manage potential aging effects of rebar corrosion for rebar layers located near laminar cracking.**

RESPONSE RAI B.2.43-6 (follow-up)

1) Opportunistic inspection of rebar when exposed will adequately manage potential aging effects of rebar corrosion for rebar layers located near laminar cracking. FirstEnergy Nuclear Operating Company (FENOC) visually inspected rebar in areas of laminar cracking at the construction opening during the 17th Mid-Cycle Outage in October and November, 2011 (i.e., after greater than 30 years of operation), and determined that the presence of cracking itself has not resulted in unacceptable rebar material loss or corrosion.

   The presence of potentially aggressive environmental conditions (groundwater) is not considered a related condition associated with the laminar cracking condition. Impulse-Response mapping completed on exterior portions of the Shield Building during the summer of 2012 did not identify laminar cracking below elevation 615'. The grade elevation at site is 584'-0" (i.e., more than 31 feet below the laminar cracking), with groundwater below that elevation. Therefore, postulated scenarios of interaction between groundwater and the laminar cracking condition are not considered credible.

   As a corrective action for the identification of laminar cracking, FENOC applied an exterior coating to the Shield Building during 2012. This coating, as documented in American Concrete Institute (ACI) 222R-85, "Corrosion of Metals in Concrete," Chapter 5, is a means to limit the availability of oxygen and moisture that are required to sustain a corrosive environment. Therefore, despite the identification of water within the concrete, FENOC has limited the introduction of additional oxygen and moisture such that the postulated corrosion rate of rebar is expected to remain minimal, with a decreasing trend.

   With respect to the water found in core bores, FENOC completed a causal investigation for the laminar cracking propagation condition. This causal analysis included chemical analysis of the water. It was concluded that the water constituents were "typical of water that was in contact with the concrete for a period of time." Water samples collected exhibited high pH values (average greater than 10). It is therefore documented that the "...water itself with salt and high pH is not conducive to generate corrosion in the rebar."

   Given the supporting evidence that the alkali environment within the concrete is inhibiting corrosion, and the mitigating nature of the coating, FENOC has elected to conduct opportunistic inspections of the rebar. Corrosion of rebar would result in visual indications such as staining, cracking and spalling on the exterior of the structure or in core bores that are located near rebar. These indications are aspects monitored under the Structures Monitoring Program to adequately manage aging of the structure, inclusive of potential rebar corrosion.

2) Based on Response 1, above, no modifications or enhancements to Davis-Besse License Renewal Aging Management Programs are necessary.