October 30, 2001

Mr. Guy G. Campbell, Vice President - Nuclear
FirstEnergy Nuclear Operating Company
5501 North State Route 2
Oak Harbor, OH 43449-9760

SUBJECT: DAVIS-BESSE NUCLEAR POWER STATION, UNIT 1 - REQUEST FOR ADDITIONAL INFORMATION RE: RESPONSE TO BULLETIN 2001-01 (TAC NO. MB2626)

Dear Mr. Campbell:

By letter dated September 4, 2001, FirstEnergy Nuclear Operating Company provided its response to Nuclear Regulatory Commission Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles." In your response, you proposed to defer inspections of the reactor vessel head penetrations recommended by the bulletin to the 13th refueling outage scheduled for April 2002. Your letter of October 17, 2001, provided supplemental information to support deferral of the inspections.

The staff has performed a preliminary review of this information and has developed the questions in the enclosed request for additional information (RAI). The RAI was previously forwarded to your staff on October 18, 2001. Responses to these questions are necessary for the staff to complete its review.

Sincerely,

/RA/

Stephen P. Sands, Project Manager, Section 2
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-346

Enclosure: Request for Additional Information

cc w/encl: See next page

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REQUEST FOR ADDITIONAL INFORMATION REGARDING

RESPONSE TO NRC BULLETIN 2001-01

CONTROL ROD DRIVE MECHANISM INSPECTION DEFERRAL

DAVIS-BESSE NUCLEAR POWER STATION, UNIT 1

FIRSTENERGY NUCLEAR OPERATING COMPANY

DOCKET NO. 50-346

Davis-Besse Bulletin 2001-01 Response (September 4, 2001)

BR-1 For the April 2000 nozzle inspection, provide additional detail regarding the scope of the visual examination, in particular, the ability to view the bare metal at the interface of the nozzles and the reactor pressure vessel (RPV) head, any restrictions to viewing any of the nozzles, and any boric acid deposits from other sources that could have masked leakage from the nozzles. Provide documentary evidence (such as photographs) characterizing the condition of each nozzle.

BR-2 For the four nozzles which cannot be demonstrated to have annular gaps at the operating conditions (as described in the Structural Integrity Associates, Inc. [SIA]) report on the finite element gap analysis), what conclusions can be reached from the visual examination of the these nozzles regarding the presence of through-wall cracks in the nozzle, a conducive environment in the annulus, and circumferential cracks in the nozzle above the J-groove weld? Provide technical justification for these conclusions.

BR-3 For the four nozzles which cannot be demonstrated to have annular gaps at the operating conditions (as described in the SIA report on the finite element gap analysis), what examinations will be performed at future inspections to provide assurance that there are no through-wall cracks nor circumferential cracks above the J-groove weld in these nozzles?

Structural Integrity Associates, Inc.
"Finite Element Gap Analysis of Control Rod Drive Mechanism (CRDM) Penetrations (Davis-Besse)"

SIA-1 Page 5 states that "the final weld connection between the hemispherical head and the CRDM tubes is via a series of degree-of-freedom couples between the nodes along the inner surface of the hole in the hemispherical head and the outer surface nodes of the CRDM tubes." Does the phrase, "a series of degree-of-freedom couples between the nodes" mean the process of equating the three displacements of a whole node to the three displacements of a corresponding tube node at the J-weld location? Is one layer of solid element in the tube thickness direction sufficient considering that at the J-weld location certain restraint is imposed on one face of this single layer of solid elements?

SIA-2 Page 6 states that pressure was applied to the hemispherical head side end of the CRDM tube and to the flange closure face out to a radius of 84.8115 inches. Indicate on Figure 5 the location that was referred to as the "hemispherical head side end of the CRDM tube." If pressure was applied to the flange closure face out to a radius of 84.8115 inches, this would be beyond the compression surface shown in Figure 2. What does this mean physically?

SIA-3 Page 6 notes that "applied cap load was actually applied in the negative direction in ANSYS, thus providing a traction load." Was the "traction" load a shear load in your definition? Clarify the "negative" direction of the traction load.

SIA-4 The FEM results indicate that four CRDM tubes (Tube 1, 2, 3, and 4) provide no gap during normal operation. What is your plan to monitor these four CRDM tubes, on which a circumferential flaw could be developed below the location of interference without giving any visual indication of leakage on the RPV head?

<u>Framatome Report 51-5012567-01, "RV Head Nozzle and Weld Safety Assessment"</u>

The staff notes that the risk assessment presented in Section 9 of this report is a Babcock & Wilcox (B&W) generic version of an analysis submitted by Oconee in their Bulletin response. At a public meeting with Oconee on September 7, 2001, the staff identified many issues with the analysis to the Oconee and Framatome staff participating in the meeting, and indicated that the analysis did not provide a sufficient risk basis. (The issues identified at the September 7, 2001, meeting are among the items requested below.) A review of the report does not indicate that any of the staff issues raised at the meeting have been addressed, and it is not clear that the report provides any new information not previously available to the staff. As indicated in Question FRA-14, the licensee should provide the staff with the identified references to the report in order for the staff to complete its review.

FRA-1 What is the crack growth rate (in./year), mean value and distribution, used in the deterministic and probabilistic fracture mechanics analyses for outside diameter (OD) circumferential cracks in Alloy 600 in the annular environment? If the values are typical of primary water stress corrosion cracking (PWSCC), why is this appropriate without consideration of any acceleration factor for this potentially aggressive environment?

FRA-2 With the probability of missing a leak 0.06 at the first inspection, 0.065 at the second inspection, and 0.11 at subsequent inspections, how is this concept incorporated in the analysis?

(a) Does the human error probability relate to nozzles that are found to be free of relevant deposits by the visual examination but may actually have flaws, or the number of nozzles that have relevant deposits?

(b) Address whether the human error probability assumptions consider the possibility that (1) the crack doesn't leak enough to the top of the head to give a visible indication; (2) the crack leaked initially, and formed some deposit that was missed in an early inspection (before the inspections were sensitive to small amounts of boric acid) and it doesn't leak anymore (due to leak plugging).

(c) The human error probability discussion assumes that there is no probability that a through-wall (or very deep) crack of some length already exists at the time of the inspection. This is essentially an inspection that is perfect in finding big cracks and only has a 0.06 chance of missing a small leak. Provide justification for assuming a "perfect" inspection for large circumferential cracks.

FRA-3 Page 26 of the report assumes that the annular environment required for OD PWSCC "will coincide roughly with the presence of visible boron crystal deposits." What is the basis for this statement, given the fact that it will take time to fill the annular region with leakage deposits prior to the presence of visible deposits on the head and the hypothesis of "leak plugging" on page 26 of the report? What is the time required from initial break-through of a through-wall crack in the weld (or interface with the nozzle) prior to visible leakage on the RPV head? How is "leak plugging" considered in the analysis presented in the report?

FRA-4 Page 27 states that "the reactor vessel head inspection process is simple and straightforward, such that a written procedure is not necessary for a successful inspection." This statement appears to conflict with Criterion V of Appendix B to 10 CFR Part 50, which states that activities affecting quality shall be prescribed by documented instructions, procedures, or drawings. Was the Davis-Besse visual examination of April 2000 performed using a written procedure?

FRA-5 What are the stress magnitudes used in the probabilistic analysis, and what are the "worst case stresses" described on page 29?

FRA-6 How do the assumptions of crack size and crack growth rate appropriately consider the effects of multiple crack initiation (and growth) sites, and how do the assumptions bound the multiple site case?

FRA-7 What link is there (if any) between the leakage rate or deposit size and the length of through-wall circumferential cracks, to support the statements on page 35 regarding detectable leakage of steam through a large through-wall circumferential crack?

FRA-8 Page 53 describes leak rates for a crack configuration similar to that observed for nozzle 56 at the Oconee Nuclear Station, Unit 3 (ONS-3), with rates ranging from 0.4 gpm to 1.2 gpm, depending on the assumed annulus clearances. How do these calculated leak rates compare to that found for nozzle 56 of ONS-3?

What are the reasons for any differences between the calculated leak rates and the field experience? Could the differences manifest themselves in similar disparities from reality for other analyses in the report?

FRA-9 Page 34 of the report states that "any circumferential flaw above the weld on the outside surface of the nozzle should not be considered a safety concern." Provide the basis for this statement and any clarification of the intent of this statement. It should be noted that flaw acceptance criteria provided in a letter from K. Wichman to A. Marion would require removal and repair of all circumferential flaws located above the J-groove weld.

FRA-10 The analysis of annulus dimensions for CRDM nozzles provided on page 50 indicates that gaps will occur for B&W-design CRDM nozzles. Recent finite element analyses from Oconee and Davis-Besse do not indicate the presence of gaps for all nozzles. How can these finite element analyses be reconciled with the statements on page 50?

FRA-11 Since the report addresses CRDM nozzles as if gaps will exist at the operating conditions, and finite element analyses do not support that conclusion in all cases, what would be the recommendations in the report for nozzles without a demonstrable gap at the operating conditions?

FRA-12 In your response letter (page 13 of an attachment) to the Bulletin stated that multiple failures of CRDM would not occur and, apparently, the bounding analysis of a single-failure for loss-of-coolant accident (LOCA) and non-LOCA would be applicable to Davis-Besse. Explain the rationale and assumptions of this statement.

(a) The initiating event frequency evaluated by the Monte Carlo simulation did not provide the basis, data, or bench marking using the available data. The result of the Monte Carlo simulation, 1.3E-5 (probability of having an OD flaw propagate in one fuel cycle to be large enough to cause catastrophic failure), did not provide detailed information including assumptions and reference documents. The analysis did not provide nor discuss the uncertainty. Probabilistic risk assessment (PRA) does not create uncertainty, but uncertainty is derived by knowledge limitations or lack of data. Provide the actual calculations, equations, and assumptions used in the evaluation.

(b) Discuss the uncertainty of the PRA results and provide the results of an uncertainty analysis.

(c) The probability of having a leaking nozzle with boric acid crystals present, but not identifying the leak as a result of human error (either failing to conduct the test of failing to detect evidence of a leak during an inspection) is estimated to be 6.0E-2 or 6 percent. Provide the supporting data and the basis for this number, and an explanation of why this 6 percent human error factor was either not included or clarified anywhere in the risk assessment.

(d) The number of flaws found by inspection that resulted in leaking nozzles experienced at Oconee and Arkansas Nuclear One Unit 1 (ANO-1) was 14 and 1, respectively. Conservatively assuming these flaws initiated over the last two operating cycles, an initiating frequency of 1.25 CRDM leaks was estimated from fifteen leaks identified in twelve reactor-years. The Nuclear Regulatory Commission (NRC) staff notes that ANO-1 is an outlier with regard to the calculation, and those 15 may not represent the state of Davis-Besse. Furthermore, the staff's calculation using just Oconee, and adding the 6 percent human error factor discussed above, results in an increase in the initiating event frequency. The assumption of two year initiation appears to be non-conservative since there may be cracks developed but not identified. Justify the applicability of these assumptions to the Davis-Besse case.

(e) Describe the Monte Carlo simulation used in the analysis. The NRC staff notes that a Monte Carlo simulation is a computational method, and is not a mathematical model for describing catastrophic failure. The staff requests the bench mark data points and the basis for the Monte Carlo simulation which resulted in the 1.3E-5 probability value. The staff needs the initiating event frequency to complete the review of the response.

(f) Provide the conditional core damage probability (CCDP) for a Medium LOCA, and if that value is different than the value presented in the individual plant examination, explain the discrepancy. In addition, the CCDP of a medium break LOCA is not conservative, it may be a bounding or limiting case based on post break configuration.

(g) Provide the Davis-Besse plant-specific conditional population dose, if available, and the supporting data and the uncertainty used to obtain the value.

FRA-13 An important consideration in the risk assessment is treatment of the recirculation blockage after gross failure(s) of CRDM(s) and other risk assessment details. For example, how were the human errors factored into the risk assessment during the initiation and mitigation phases of the postulated bounding accident analyses? Provide the core damage probability (not conditional core damage probability, given event initiation) and frequency of the bounding LOCAs as well as their dependency with time since the probability of the event initiation would be depend on the duration of operation as postulated in the susceptibility model. How does the cumulative core damage probability increase for three months or six months operating time?

FRA-14 To complete our review of this report, provide References 8, 18, 25, 29, 30, 31, 34, and 38 (pages 38-40).