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Date: Wed, Jun 13, 2007 2:59 PM
Subject: FirstEnergy Nuclear Operating Company Response to May 14, 2007 DFI

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Mark Franke

G. Halnon

Ladies and Gentlemen,
Attached is FirstEnergy Nuclear Operating Company's reply to the May 14, 2007 Demand For Information. Please call me if you have any questions or trouble opening the document. The document is being mailed today to the Document Control Desk, original to Ms. Carpenter and copies to Assistant General Counsel for Materials Litigation and Enforcement and the Regional Administrators.
Regards

Greg Halnon
Director Regulatory Affairs
FirstEnergy Nuclear Operating Company
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(See attached file: FENOC Response to May 14 2007 DFI.pdf)

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FENOC
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June 13, 2007

BV-L-07-082
DB-Serial Number 3350
PY-CEI/NRR-3044L

Ms. Cynthia A. Carpenter
Director, Office of Enforcement
United States Nuclear Regulatory Commission
Washington, DC 20555-0001

Beaver Valley Power Station, Unit Nos. 1 and 2
Docket Nos. 50-334 and 50-412

Davis-Besse Nuclear Power Station, Unit No. 1
Docket No. 50-346

Perry Nuclear Power Plant, Unit No. 1
Docket No. 50-440

Subject: **Response to Demand for Information**

This letter provides the response from FirstEnergy Nuclear Operating Company (FENOC) to the May 14, 2007, Demand for Information (DFI) from the Nuclear Regulatory Commission (NRC) relative to the "Review and Analysis of the Davis-Besse March 2002 Reactor Pressure Vessel Head Wastage Event," prepared by Exponent Failure Analysis Associates and Altran Solutions Corporation (Exponent Report) and the "Report on Reactor Pressure Vessel Wastage at the Davis-Besse Nuclear Power Plant," prepared by Roger J. Mattson, Ph.D. (Mattson Report). These reports were provided to FENOC by its contractors in December 2006 as part of an insurance arbitration with Nuclear Electric Insurance Limited (NEIL). Attachment 1 contains the response to the DFI.

I want to take this opportunity to address three key issues that have arisen out of the sequence of events leading up to this DFI. First, FENOC reaffirms our responsibility for performance related to the Reactor Pressure Vessel (RPV) head degradation event, as well as the mistakes and omissions related to that event. Second, we recognize our May 2, 2007 response to the NRC's Request for Information of April 2, 2007 was primarily focused on the detailed analytical studies that form the basis for the Exponent Report's timeline for the crack growth and wastage phenomenon (wastage is the mechanism that developed the cavity in the RPV head), and was not a comprehensive review of the differences between our root cause reports and the Exponent Report. Third, we continue to believe the root cause of the RPV head degradation event was our failure to properly implement the Boric Acid Corrosion Control (BACC) program and there is nothing that we have reviewed in the Exponent Report or the Mattson Report that has changed this conclusion. Specifically, if the BACC program had been implemented correctly, leakage from Control Rod Drive Mechanism (CRDM) nozzles would have been detected prior to the twelfth refueling outage (12RFO) in 2000. These issues will be explained more fully in the text of this response to the DFI.

In our response to Demand A in the DFI, we describe how FENOC considered the potential safety significance of the report upon receipt and steps we implemented after NEIL raised a potential safety concern, including the process used by FENOC that led to the decision to notify and provide a copy of the Exponent Report to the NRC. We explain the processes used that led to preparation and subsequent processing of the Exponent Report. The Exponent Report was prepared as part of an insurance arbitration; however, a nuclear process for receipt and review of technical reports produced for commercial purposes regarding the nuclear station did not exist.

As discussed in our response to Demand A, FENOC believes there is no regulatory requirement to have reported the information in the Exponent Report to the NRC. However, if FENOC had processed the report under a defined program with defined review criteria, we believe we would have been more sensitive to the regulatory significance of this new information and to the NRC's need to independently determine the significance to their oversight process. This would have provided an opportunity to have engaged the NRC earlier in the process.

Finally, in Demand A, we provide an analysis of the May 2, 2007 FENOC response to the NRC letter of April 2, 2007 requesting information on the Exponent Report. We clarify that in our May 2, 2007 response, we did not focus on the Exponent Report's overall conclusions and assumptions; and now recognize that our narrow perspective did not fully satisfy the NRC's request. Accordingly, we did not sufficiently consider the operational data that formed the basis for the Significant Degradation of the Reactor Pressure Vessel Head Root Cause Report (Technical Root Cause Report) conclusion that there was reactor pressure boundary leakage for a prolonged period. Our letter may have inappropriately given the impression that we endorsed all aspects of the Exponent Report, including that part of the assessment that conflicts with our Technical Root Cause Report. Specifically, we did not intend to create the impression that we could not have identified leakage prior to 12RFO had we cleaned the RPV head.

FENOC continues to believe that the current Technical Root Cause Report and the Failure to Identify Significant Degradation of the Reactor Pressure Vessel Head Root Cause Report (Management and Human Performance Root Cause Report) provide a comprehensive explanation of the progression and causal factors of the Davis-Besse RPV head degradation event and, hence, contain the most appropriate information to have used in development and implementation of corrective actions to prevent recurrence.

We conclude that throughout this insurance claim process FENOC has maintained a focus on safety. However, we also conclude that we were not sensitive to the potential regulatory interest during the review of the Exponent Report and Mattson Report.

In response to Demand B in the DFI, we provide a discussion of the approach we took to evaluate the differences between the Exponent Report and the FENOC technical and programmatic root cause reports, particularly how these reports considered operational experience data. The Exponent Report proposed a timeline of crack growth and subsequent wastage development based on an analysis of recent data and subsequent metallurgical analysis. It is not a root cause report, but is a technical analysis that proposes a detailed description of the physical degradation that occurred in the nozzle cracking and wastage development at Nozzle 3 of the Davis-Besse RPV head. The conclusions of the Exponent Report are a product of the methods used and the focus of a technical analysis as opposed to the root cause reports, which were broad-based and intended to fully address the organizational issues surrounding the event. A principal difference in the conclusions of the Exponent Report and the root cause reports is in regard to the timeline for identification of detectable leakage. FENOC continues to believe that, if the BACC program had been implemented correctly, leakage from CRDM nozzles would have been detected prior to 12RFO.

We also address whether identified differences demonstrate a need for any new or different corrective actions, as well as the continued effectiveness of previous corrective actions. We conclude that, although there are many differences in the assumptions and analytical methods used in the various reports, the conclusions reached based on a review of the reports do not present a new safety concern nor do they demonstrate a need for any new or modified corrective actions. However, as a result of our ineffective communication upon receipt of the Exponent Report, FENOC's policy on Regulatory Communications will be assessed for potential enhancements.

We also conclude that the FENOC Technical Root Cause Report and Management and Human Performance Root Cause Report represent the fundamental causal factors for the Davis-Besse RPV head degradation event and remain our position in terms of causes and corrective actions.

In response to Demand C in the DFI, FENOC sets forth each of the conclusions in the Mattson Report related to the RPV head degradation event and identifies those that FENOC does or does not endorse. We also address whether the conclusions we endorse impact the continued effectiveness of previous corrective actions, and if they are in conflict with the root cause reports, the licensee event report, or FENOC's responses to NRC's April 21, 2005, Notice of Violation and Proposed Imposition of Civil Penalties. We conclude that, although we agree with some statements and conclusions in the Mattson Report, FENOC does not endorse the report in its entirety. This is further clarified in our Response to Demand C.

FENOC acknowledges we have not been fully effective in communicating with the NRC upon receipt of the two reports. We should have communicated more effectively internally and more promptly with the NRC relative to information developed by our consultants as part of the insurance arbitration process. FENOC is particularly concerned that a perception may exist that FENOC was attempting to deviate from its earlier acceptance of responsibility. Through the many conversations with the NRC and in docketing the materials, FENOC has consistently attempted to demonstrate complete candor and openness relative to NEIL's potential safety concern and FENOC's subsequent evaluation. We failed to ensure the NRC was provided sufficient information to understand the process and the context in which the two experts prepared their reports. We will be more sensitive to this interest in the future and will communicate with the NRC in a timelier manner. In this regard, we will institute a process that assures information developed in a commercial proceeding is sufficiently screened for potential impact on safety and regulatory matters.

Beyond this response, we have made an effort to clear up any misconception about this issue in recent media coverage. We distributed a letter from Mr. Anthony J. Alexander, Chief Executive Officer of FirstEnergy, to the local media editors, stating that FENOC *continues to accept full responsibility for the reactor head damage that was found in* 2002 at our Davis-Besse nuclear plant. In addition, we have communicated with our employees through company publications and employee meetings to discuss the expert reports, the insurance arbitration, and our primary obligation to assure our plants continue to be operated in a safe manner. In this regard, our current meetings re-emphasize the primary mission of safe operations and maintaining an environment that promotes differing points of view on issues.

FENOC takes this opportunity to reaffirm our responsibility for performance related to the RPV head degradation event, as well as the mistakes and omissions related to that event. We also reaffirm our Technical Root Cause Report and Management and Human Performance Root Cause Report that FENOC considered in developing its comprehensive corrective actions and NRC considered in its restart decision. FENOC particularly reaffirms its response to NRC's Notice of Violation and Proposed Imposition of Civil Penalty (as documented in our response, dated September 14, 2005, and supplemented on January 23, 2006) and continues to accept full responsibility for our past failure to properly implement the BACC program and corrective action program (CAP). Further, in the Deferred Prosecution Agreement between FENOC and the Department of Justice, FENOC accepted responsibility and admitted that the Department could prove that from September 3, 2001, through November 28, 2001, FENOC employees, acting on its behalf, knowingly made false representations to the NRC.

FENOC believes that its overall record of sustained improvement over the past five years in operating its four plants provides the NRC with reasonable assurance that FENOC has and will continue to operate its licensed facilities with a strong safety focus and in accordance with its licenses and the Commission's regulations. Additionally, lessons learned from the recent activities emphasize to us the importance of utilizing our nuclear processes for assessment of commercial documents that are prepared on behalf of FENOC. FENOC will develop a formal process to review technical reports prepared as a part of a commercial matter. The process will provide criteria for FENOC to utilize to determine if the report has the potential for regulatory implications or impact on nuclear safety both at our sites and within the nuclear industry. This process will provide for the timely and critical evaluation of this type of report and will complement our existing formal nuclear process for obtaining technical reports from our agents and contractors.

Attachment 2 identifies the actions committed to by FENOC as part of our response to this DFI. I am available to answer any questions you may have regarding FENOC's response. Should you wish to contact me, I can be reached at (330) 761-7895. You should also feel free to contact Mr. Gregory H. Halnon, Director, Fleet Regulatory Affairs, at (330) 384-5638.

Sincerely,

JJHagan

Joseph J. Hagan
President and Chief Nuclear Officer, FENOC

Affidavit

Attachments (2)
1. Response to Demand For Information
2. Commitment List

CC: Document Control Desk
Assistant General Counsel for Materials Litigation and Enforcement
Regional Administrator, NRC Region I
Regional Administrator, NRC Region III
NRC Project Manager – Davis-Besse and Perry
NRC Resident Inspector - Davis-Besse
NRC Project Manager – Beaver Valley
NRC Resident Inspector – Beaver Valley
NRC Resident Inspector - Perry Nuclear
Utility Radiological Safety Board
Mr. D. A. Allard, Director BRP/DEP
Mr. L. E. Ryan, BRP/DEP
Ms. N. Dragani, Ohio Emergency Management Agency

BV-L-07-082
DB-Serial Number 3350
PY-CEI/NRR-3044L

Affidavit

I, Joseph J. Hagan, being duly sworn, state that I am the President and Chief Nuclear Officer for FirstEnergy Nuclear Operating Company ("FENOC"), that I am authorized to sign and file this application with the Nuclear Regulatory Commission on behalf of FENOC and its affiliates, and that the statements contained in this submittal, including its associated attachments, are true and correct to the best of my knowledge and belief. I am authorized by the FirstEnergy Nuclear Operating Company to make this submittal. I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

JJ Hagan

Joseph J. Hagan
President and Chief Nuclear Officer

STATE OF OHIO

COUNTY OF SUMMIT

Subscribed and sworn to before me, a Notary Public, in and for the County and State above named, this 13th day of June, 2007.

Terri L. Hunsinger

My Commission Expires: Terri L. Hunsinger
Notary Public - State of Ohio
My Commission Expires 5/5/11

Attachment 1
Response to Demand

Demand A

A detailed discussion of the process used, the specific information evaluated, and the conclusions reached as a part of FENOC's assessment of the Exponent Report, upon receipt or subsequently, to determine if the Exponent Report assumptions, analyses, conclusions, or other related information, should have been reported to the NRC in a more prompt manner. Your response shall include sufficient information for the NRC to assess how FENOC evaluated the significant differences between the crack growth and leakage timelines developed in the Exponent Report and previous root cause reports.

I. Introduction

FENOCs response to Demand A describes the processes that exist at FENOC to evaluate potentially safety significant information that is received from both inside and outside the company. The response then explains the insurance arbitration process, which is outside the normal nuclear processes and led to preparation of the Exponent Report. This response next provides a chronology of pertinent events that describe how FENOC considered the potential safety significance of the report upon receipt, including its reporting obligations and the process used by FENOC after Nuclear Electric Insurance Limited (NEIL) raised a potential safety concern. Following those sections, this response discusses the May 2, 2007, letter.

For the reasons set forth below, FENOC believes there is no regulatory requirement to have reported the information in the Exponent Report to the NRC earlier; however, consistent with FENOC's practice of open and candid communications with the NRC on matters having potential regulatory interest, FENOC should have advised the NRC of the content of the Exponent Report after its initial review in December 2006 or earlier. At the same time, from initial receipt of the Exponent Report, FENOC maintained a focus on the safety aspects of the Exponent Report throughout the course of its review. If FENOC would have processed the report under a defined program with review criteria, we believe there would have been a higher sensitivity to the interests surrounding the Davis-Besse Reactor Pressure Vessel (RPV) head degradation event, which could have alerted FENOC to engage the NRC earlier in the process. We acknowledge our continued responsibility to communicate important information to the NRC.

II. Normal Nuclear Processes

There are a number of processes within FENOC's nuclear program to ensure the Company considers the safety and regulatory implications of information received from outside the organization. FENOC procedure NOP-LP-2001, Corrective Action Program, (CAP) provides a comprehensive process for identifying and documenting adverse conditions, their cause(s), and the actions necessary to correct the conditions and/or prevent their recurrence. The appropriate use of the CAP allows concerns and potential concerns to be identified and systematically evaluated and corrected. CAP satisfies the requirements of 10 CFR 50, Appendix B, Criterion XV, Nonconforming Materials, Parts, or Components, and Criterion XVI, Corrective Action. The CAP procedure also references a process, Activity Tracking, that is intended to track and resolve issues that do not meet the definition of an adverse condition. In addition, FENOC's Policy for Maintaining a Safety Conscious Work Environment, describes the responsibility for FENOC and contractor employees to promptly report identified nuclear safety, quality, reliability, and regulatory compliance concerns that affect FENOC facilities. This process also provides for an alternate problem resolution process.

Additionally, FENOC has procedures that provide guidance for evaluating Operating Experience (OE) and Vendor Technical Information (VTI). The OE program is used to evaluate documents such as those provided by the Institute of Nuclear Power Operations (INPO), NRC Information Notices, selected NRC findings and violations from other FENOC sites, and selected Licensee Event Reports (LERs) from other FENOC sites. Responses to NRC Bulletins and Generic Letters are governed by Fleet Licensing procedures. As part of the VTI process, if questions are raised, FENOC will return the document to the vendor for comment resolution, or submit it to be processed in accordance with the Design Interface Reviews and Evaluations and/or the Owner Acceptance Review process. FENOC also has an Engineering Calculations Program that requires organizations outside of FENOC to provide specific documentation along with the calculation, including inputs, references, methodology, a summary of the results, and a list of assumptions, limitations, and restrictions.

These reports, prepared as part of a commercial dispute over insurance coverage, did not fit squarely into any of the nuclear programs. This is not unique to insurance claims. Other examples could include commercial dealings, such as due diligence reviews associated with the purchase or sale of a nuclear facility, engagement in disputes regarding commercial aspects of equipment performance, and state prudence proceedings. FENOC recognizes the need to ensure that information created on commercial matters, which has the potential for regulatory implications, impact on the licensing or design basis of the FENOC nuclear units, or impact on nuclear safety both at our sites and within the nuclear industry, is appropriately reviewed. This is discussed in more detail in Section VII.

III. Insurance Arbitration Process

FENOC purchased what are known as all risk policies from NEIL to protect against damage to its property and from losses at its plants. All risk policies cover losses by the insured that are the result of "fortuitous events" and not the result of "ordinary wear and tear." Following the Reactor Pressure Vessel (RPV) head degradation event at Davis-Besse, FENOC submitted an insurance claim with NEIL. The insurer disputed the claim and it proceeded to arbitration.

FENOC retained expert witnesses to prepare opinion testimony in support of the insurance claim. Expert witnesses are routinely used in insurance claim cases and other legal proceedings to provide expert opinion in support of a party's position. According to the terms of the insurance policy, the claimant must demonstrate that the costs associated with the claim were the result of "a sudden and fortuitous event, an event of the moment, which happens by chance, is unexpected and unforeseeable" (specific language in the insurance policy).

The purpose of the Exponent Report was to provide an independent review of the Davis-Besse head degradation event and render an opinion on coverage under the policy.

Roger Mattson, Ph. D. was also hired to provide expert testimony in this arbitration. His report, "Report of Reactor Pressure Vessel Wastage at Davis-Besse Nuclear Power Plant" related to the development and implementation of the Boric Acid Corrosion Control (BACC) Program at the Davis-Besse station.

Expert testimony, as used in this arbitration, relies on the special expertise of the witness. Opposing counsel has the opportunity to cross-examine the expert witness and to provide an expert witness of its own to refute the testimony of the other party's expert witness. Thus, expert testimony is, by nature, an opinion that may or may not be able to be definitively proved. It is up to the arbiters to weigh the significance of the expert testimony in rendering judgment.

This type of proceeding is intended to be a non-public proceeding between two parties in resolving an insurance claim. The parties also entered into an agreement governing the manner in which FENOC's claim would be arbitrated. In accordance with that agreement, FENOC provided NEIL with a statement of its claims and NEIL provided FENOC with a statement of its defenses. The Exponent Report and the Mattson Report are intended to address key terms in the insurance policy as well as defenses which NEIL has raised.

It is important to recognize that the terms in the insurance policy are construed under New York insurance law, and the laws of other jurisdictions, and are not necessarily given the common dictionary definition.

Exponent considered the standards in the policy, exercised its expert judgment, and found that the damage was not the result of ordinary wear and tear, and based on an analysis using data developed subsequent to the RPV head degradation event, concluded that the damage to the reactor head meets the terms of the policy.

It should be noted that, similar to the Exponent Report, the Technical Root Cause Report found that "significant damage" to the reactor head was "unexpected." The Exponent Report finds that the event happened by chance and was unexpected and not foreseeable (language specifically from the insurance policy). It presents these findings, by a review of industry experience with nozzle cracking in pressurized water reactors and by its detailed modeling of the event. The Exponent Report addressed this definition and concluded, based on an analysis using data developed subsequent to the RPV head degradation event, that the damage to the reactor head meets the definition of an accident in the insurance policy.

NEIL contends, among other things, that the event was "expected" and "foreseeable" because, in its view, FENOC willfully violated the BACC program thus making the event, in NEIL's view, both "expected" and "foreseeable." Dr. Mattson provided his opinion in response to NEIL's assertion in his report. This is further discussed in the response to Demand C.

IV. FENOC Receipt of the Exponent Report

Early in December 2006, FENOC counsel received drafts of the Exponent Report and the Mattson Report. On December 5, 2006, the Mattson Report and sections of the Exponent Report were routed to a limited number of individuals within FENOC for review. This included several members of FENOC senior management and other reviewers who had knowledge of the Davis-Besse RPV head degradation event.

No specific review criteria or acceptance process was provided to the reviewers, and the scope and level of the reviews varied. Several reviewers had comments, some were written and some were provided orally. For example, some reviewers noted that the Exponent Report timeline for postulated Control Rod Drive tube crack development and head wastage was much shorter than that put forth by the Technical Root Cause Report. Resolution of the comments was not entered into FENOC's Record Management System because FENOC did not review the report under a formal nuclear process.

During this review of the draft Exponent Report, FENOC executive management raised the question whether the report could have possible safety implications. Senior Counsel relayed information related to Exponent's conclusion that its analysis did not raise a safety concern and that the industry inspection guidance is adequate. Staff involved with the drafting of the Technical Root Cause Report likewise commented on the difference in the corrosion/wastage timeline.

The draft Exponent Report that circulated within FENOC for review explained that if the current NRC-ordered inspections had been in place at 12RFO in 2000, the cracks in CRDM nozzles would have been identified and repaired and the head wastage would not have happened. This explanation was not included in the formal report because it was part of a larger section that was condensed prior to issuing the final report.

On December 18, 2006, the Exponent Report was submitted to NEIL as expert testimony in support of the FENOC insurance claim.

FENOC management concluded that there was no new safety concern in the report, that information in the report did not call into question the effectiveness of corrective actions implemented in response to the Davis-Besse RPV head degradation event, and that the report did not otherwise contain information that had significant implication for public health and safety. This conclusion was based upon information from Exponent, review of the report by knowledgeable technical managers, and was formed after consultation with counsel. Resolution of the comments was not entered into FENOC's Record Management System because FENOC reviewed the report under an insurance arbitration process which is not a formal nuclear process.

V. FENOC Actions Upon Receipt of NEIL's February 23, 2007, Potential Safety Concern

In a letter to FENOC, dated February 23, 2007, NEIL stated that they were concerned that the cause and timeline in the Exponent Report presented a "potential safety concern." Specifically, NEIL stated:

> If the theories in the Exponent Report are correct, it could require reevaluation of the adequacy of these NRC [inspection] requirements and the licensee programs implementing them to ensure that excessive degradation of a reactor pressure vessel head or other components could not occur in less than one operating cycle.

In this letter, NEIL identified a potential safety concern regarding the Exponent Report. NEIL also asked FENOC to answer six questions regarding the actions that FENOC had taken, or was planning to take, in response to the opinions and conclusions in the Exponent Report. These included questions on whether FENOC was contemplating submitting a revised root cause report to the NRC or was planning on sharing the opinions and conclusions in the Exponent Report with the nuclear industry.

On February 23, 2007, during a conference call between FENOC and Exponent, Exponent was asked to provide its view of NEIL's potential safety concern. Exponent had previously analyzed the inspection requirements when preparing the draft of the Exponent Report and explained that given the time sequence of the growth of the crack as described in the Report, it would have been discovered during 12RFO in 2000 under the current NRC inspection requirements and that, in Exponent's view, there was no safety concern.

That day, in accordance with CAP, FENOC generated Condition Report (CR) 07-15077 to formally capture and evaluate NEIL's potential safety concern. This CR was evaluated and FENOC determined that we do not believe "the existing industry analyses for Alloy 600 RCS [Reactor Coolant System] components at Davis-Besse, or the inspection requirements for the detection of cracks in such components are affected by the high crack growth rates theorized in Exponent's report."

The FENOC CNO also directed Exponent to work with FENOC in developing a reply to NEIL, and specifically directed that FENOC consider reportability.

Also on February 23, 2007, FENOC personnel contacted the Davis-Besse NRC Senior Resident Inspector and advised him of the NEIL letter, the potential safety concern raised in the letter, and that the potential safety concern was being evaluated in the FENOC CAP. Subsequently, FENOC made the NEIL letter available for the Senior Resident Inspector's review. FENOC management also promptly contacted NRC Region III management and discussed the receipt of the NEIL letter, informing them that the concern was being evaluated, that FENOC did not believe that the concern raised in the NEIL letter posed a safety concern, but that it was entered as a CR in the FENOC CAP to be appropriately evaluated.

FENOC management contacted the NRC Headquarters and informed them of the NEIL letter, NEIL's potential safety concern, that FENOC was addressing the issue through its CAP, and that FENOC's initial view was that the NRC's current inspection regime was sound.

In a letter dated March 7, 2007, FENOC responded to NEIL's potential safety concern. The letter stated that:

> As with any potential safety concern, we (Davis-Besse staff) promptly prepared a Condition Report and analyzed your concern in accordance with the FENOC Corrective Action Program. Based on our analysis, we do not believe that the conclusions of the Exponent Report identify a safety issue at Davis-Besse and have dispositioned your letter accordingly.

Consistent with its focus in December, this demonstrates FENOC's focus on its obligation to determine whether the NEIL letter presented a safety concern.

On March 9, 2007, Davis-Besse plant personnel held a conference call with the NRC and Exponent. The purpose of the call was to discuss NEIL's potential safety concern and its resolution. Also on the call were the authors of the Exponent Report, who explained the background of the report. Davis-Besse personnel explained FENOC's conclusion that NEIL's potential safety concern was not substantiated because of the current inspection requirements for RPV nozzles.

In a letter to FENOC dated March 15, 2007, two members of NEIL's Board of Directors requested that the Exponent Report be shared with the Materials Executive Oversight Group (MEOG) that had been established by the Nuclear Energy Institute (NEI). FENOC discussed this request with NEI on March 16, 2007.

On March 19, 2007, FENOC held a conference call with the NRC to advise the NRC that the Exponent Report would be submitted to the NRC and NEI. It was agreed that the NRC and FENOC would hold a follow-up call later that week to discuss the Exponent Report's analysis and conclusions in more technical detail. During the course of the call, the NRC asked for the status of the CR (CR 07-15077) dealing with NEIL's potential safety concern. FENOC reported that the plant evaluation did not identify any new safety concern and that no additional corrective actions were required.

On March 20, 2007, FENOC submitted the Exponent Report to the NRC.

On March 21, 2007, FENOC transmitted a copy of the Exponent Report to NEI. FENOC requested that MEOG "conduct an evaluation of whether the crack growth rates and RPV head wastage mechanisms identified in the Exponent Report call into question the adequacy of the industry's operational monitoring and periodic inspection requirements, and the programs implementing them, or otherwise raise a generic safety concern."

FENOC participated in a conference call with the NRC and Exponent on March 22, 2007. During the call, Exponent described its report and conclusions. This call provided the NRC the opportunity to hear Exponent discuss its analysis and ask questions. FENOC reiterated during the call that it did not believe Exponent's report raised an added safety concern, but that it built upon the Technical Root Cause Report, provided a plausible scenario, and that no additional corrective actions were warranted.

In a letter dated March 22, 2007, FENOC informed the two NEIL Board members that FENOC would provide MEOG with a copy of the Exponent report and assist MEOG in its review. This letter also included an explanation that FENOC had discussed the report with the NRC, and had transmitted a copy of the report to the NRC.

In the last week in March, FENOC obtained an opinion from an industry consultant with extensive regulatory experience on the issues of:

> (1) do Exponent findings significantly change or impact the basis of FENOC and NRC restart decisions; and
>
> (2) what, if any, reports should be made to NRC (such as revised root cause or licensee event reports) on the Exponent assessment.

His conclusion for question (1) was:

> The Exponent Report does not raise issues that would undercut the basis for NRC's restart approval. Replacement of the reactor vessel head essentially eliminated this as an issue.

He indicated that NRC reports issued before restart, which recognized the progression of vessel head degradation could have proceeded much faster than the FENOC root cause analysis suggested, were also important in this regard.

His conclusion for question (2) was:

> Whether a supplemental LER is needed or not is a close call. Strong arguments can be made on either side. My opinion is that a supplemental LER would not be **required**, provided (1) strong steps are taken to disseminate results to NRC and other stakeholders and (2) the basis for this decision is clear. This is a very unique case; I could find no precedent. Supplementing the LER on a voluntary basis might be **prudent** to avoid questions on the matter. (emphasis in original)

He provided additional insightful comments saying the importance of sharing the Exponent Report was that it appeared to be significant and offered a new explanation of RPV head degradation. He also stated that, however the reportability issue was decided, "a rigorous analysis which compares Exponent report conclusions with those previously reported in documents such as the initial root cause analysis is needed." Further he recommended discussions with NRC on our rationale for formal reporting should follow this technical review.

On April 2, 2007, the NRC issued a letter to FENOC requesting responses to four issues within 30 days. In summary, these questions asked FENOC to provide our perspective on the overall conclusions and assumptions in the Exponent Report, to discuss any differences between the Exponent Report information and conclusions and information previously provided in our Root Cause Analysis Report and Licensee Event Report for the Davis-Besse RPV head wastage event, to discuss any implications, or lack thereof, regarding the adequacy of the specific and more broad-based corrective actions, and to discuss whether we intend to revise our Root Cause Analysis Report and Licensee Event Report.

A teleconference was held to discuss the Exponent Report with the expert panel of MEOG. Participants included authors of the Exponent Report.

Davis-Besse initiated a CR (CR 07-17452) on April 3, 2007, to capture the questions presented in the April 2, 2007 letter from the NRC. The purpose of the CR was described as follows:

> As a result of the information received [the Exponent Report], the Root Cause Evaluations performed under Condition Report 2002-00891, entitled Control Rod Drive Nozzle Crack Indication, will be reviewed under this Condition Report to determine if the corrective actions taken as a result of these root causes performed as a result of the initial RPV head leakage, bound the conclusions reflected in the report by Exponent Failure Analysis Associates.

The statements in the CR reflect that the line personnel involved assumed the Exponent Report conclusions were possible for the purpose of the review. This reflects a conservative approach to dealing with the information on the timeline of the physical head wastage in the report and demonstrates FENOC's continued focus on safety.

In order to address this CR, FENOC conducted a review of the corrective actions from the Technical Root Cause Report and Management and Human Performance Root Cause Report prepared in response to CR 02-00891, and actions taken in response to the Confirmatory Action Letter, Order EA-03-009, and NRC Bulletins 2001-01, 2002-01, and 2002-02. The review was focused on the conclusions in the Exponent Report related to its timeline for the degradation of the RPV head.

During a conference call on April 3, 2007, NRC requested and FENOC agreed to formally transmit a copy of the February 23, 2007, NEIL letter to the NRC.

In a letter dated April 4, 2007, FENOC submitted the NEIL letter to the NRC. The letter contains an explanation that FENOC did not believe that the inspection requirements for the RPV head were adversely affected by the crack growth rates used in the Exponent Report and that FENOC was performing a review of the root cause evaluations "to ensure that the conclusions in the Exponent Report are bounded by the Corrective Actions from these Root Cause Evaluations."

On April 6, 2007, FENOC initiated CR 07-17600, "to document answers to six specific questions that were raised in a letter from [NEIL] to FENOC, dated February 23, 2007." The CR also stated that it was opened for "documentation purposes to contain the answers to the questions raised in the February 23, 2007 NEIL letter."

On approximately April 25, 2007, the NRC posed a question as to the number of pages contained in the Exponent Report. NEIL had inaccurately asserted that the report was 757 pages while the report is actually 661 pages. The Davis-Besse NRC resident inspector contacted Davis-Besse Regulatory Compliance regarding the discrepancy. After looking into the matter, FENOC reported back to the NRC resident inspector that the 757 pages referred to by NEIL included a second report by Dr. Mattson.

On May 1, 2007, the response to the investigation related to CR 07-17452 was approved. The Investigation Summary documents the following conclusions:

> The rationale used in the review was focused on the conclusions in the Exponent Report related to the timeline aspect of the degradation. The conclusion of this part of the review was that none of the specific or more broad-based corrective actions for the Davis-Besse RPV head wastage event are affected by the more rapid timeline for the head wastage that the Exponent Report sets forth.
>
> The corrective actions, both completed and on-going, are adequate to assure the safe operation of the Davis-Besse Nuclear Plant. No modifications to any of the corrective actions were determined to be necessary for either the root cause corrective actions,

> the subject Confirmatory Action Letter, Order EA-03-009, or NRC Bulletins 2001-01, 2002-01, and 2002-02 as a result of the Exponent Report.

On May 1, 2007, FENOC discussed the contents of the planned response to the NRC's April 2, 2007, letter with the NRC Region III Director of Reactor Projects.

On May 2, 2007, FENOC responded to the four issues raised in the NRC April 2, 2007 letter. A clarification of this response is included in part VIII of the response to Demand A.

On May 4, 2007, the NRC advised the Department of Justice (in the ongoing criminal proceedings against former FENOC employees) that they have "determined that no immediate action with respect to Davis-Besse or other nuclear power plant is warranted." Specifically, the NRC determined that the "current inspection requirements are sufficient to detect degradation of a reactor pressure vessel head penetration nozzles prior to the development of significant head wastage even if the assumptions and conclusions in the report relating to the wastage of the head at Davis-Besse were applied to all pressurized water reactors."

Also on May 4, 2007, FENOC formally submitted the Mattson report to the NRC to resolve the page discrepancy question noted above.

In a memorandum dated May 4, 2007, the NRC provided its assessment of the Exponent Report. The cover memorandum states:

> Based on our assessment of the report, NRC staff reconfirmed that current RPV head inspection requirements under the First Revised NRC Order EA-03-009, dated February 20, 2004, are adequate to identify primary water stress corrosion cracking prior to development of significant head wastage as stated by the Exponent Report scenario.

On May 9, 2007, NEI sent its assessment of the Exponent Report to the NRC. NEI summarized its assessment as follows:

> 1. Do the crack growth rates and reactor pressure vessel (RPV) head wastage mechanisms identified in the report call into question the adequacy of the industry's monitoring and inspection programs?

> Response: No. We [NEI] believe the industry's materials monitoring programs are sound and will help maintain safe operation of nuclear power plants...The industry's operational monitoring and inspection programs as they relate to managing degradation of Alloy 600 nozzles located in the RPV head are capable of preventing the type of conditions postulated in the Exponent report.
>
> 2. Does the information in the report raise a potential generic safety concern?
>
> Response: No. The expert panel reviewed the reported crack growth rates and RPV head wastage analysis and concluded there is no potential generic safety concern. Plant safety is not jeopardized because the postulated crack growth rates are within the distribution considered for nozzle cracking and the wastage rates are consistent with the upper bounds of boric acid corrosion. This coupled with the industry's operational monitoring and inspection programs will continue to assure plant safety.

On May 14, 2007, the NRC issued a Demand for Information to FENOC in response to information provided by FENOC relative to its re-analysis of the timeline and root causes for the 2002 Davis-Besse reactor pressure vessel head wastage event.

At this point, FENOC, NEI, and the NRC had independently concluded: 1) the report does not raise a safety concern; and 2) the report does not call into question the adequacy of industry's monitoring and inspection programs.

VI. Discussion of Reportability Determination

A reportability review is performed for each CR entered into CAP. This evaluation reviews the 10 CFR 50.72 and 10 CFR 50.73 requirements for NRC notifications and LERs. NUREG 1022, "Event Reporting Guidelines – 10 CFR 50.72 and 50.73," and supervisor discussions are routinely used as additional tools. The introduction of the first CR, CR 07-15077, on February 23, 2007, brought this issue into a nuclear process, the CAP, where it was formally reviewed for reportability. The box in the CR asking whether the matter was reportable was checked "No." This box is checked by the Regulatory Compliance Group at Davis-Besse to document the reportability determination for identified conditions in accordance with 10 CFR 50.72 and 10 CFR 50.73. The supervisory comment in the CR goes on to state that a "new condition report will be written if the evaluation determines a degraded or nonconforming condition." CR 07-15077 quoted from the NEIL letter in describing the concern:

> In particular, [in a report submitted to NEIL, the] apparent position [of the report's preparer] is that susceptible materials can have crack growth rates that are significantly higher than previously assumed and small through wall cracks can lead to high rates of erosion and corrosion. Material susceptibility and crack growth rates are one of the bases for the NRC requirements for monitoring reactor coolant system unidentified leak rates during power operation, visual (bare metal) inspections of reactor pressure vessel heads during refueling outages, and periodic volumetric examination of penetrations. If the theories in the [report] are correct, it could require reevaluation of the adequacy of these NRC requirements and the licensee programs implementing them to ensure that excessive degradation of a reactor pressure vessel head or other components could not occur in less than one operating cycle.

This CR reflects FENOC's belief that its obligation was to determine whether any new insights constituted a safety concern. The investigation summary concluded that we do not believe "the existing industry analyses for Alloy 600 RCS components at Davis-Besse, or the inspection requirements for the detection of cracks in such components, are affected by the high crack growth rates theorized in Exponent's report."

In response to NEIL's concern, and in addition to the review under the CR process, FENOC has further evaluated its reporting obligations to the NRC with regard to the opinions and conclusions contained in the Exponent Report relative to: (1) the Confirmatory Action Letter (CAL); (2) the Licensee Event Report (LER); (3) 10 CFR Part 21; and (4) Completeness and Accuracy of Information (10 CFR 50.9).

FENOC concluded that there was no formal obligation to supplement the information provided for in response to the CAL, nor was there a formal obligation to supplement the LER. The LER concerning the Davis-Besse RPV head degradation, LER 346/2002-02-00, dated April 29, 2002, contains similar language to the Root Cause Report regarding the causes of the RPV head degradation:

> The apparent cause of the axial flaws resulting in pressure boundary leakage was determined to be Primary Water Stress Corrosion Cracking (PWSCC). The root cause of the RPV head condition is boric acid corrosion resulting from moisture introduced due to PWSCC cracking of CRDM [Control Rod Drive Mechanism] Nozzle 3, which occurred over a significant period of time, and which was not discovered due to an inadequate Boric Acid Corrosion Control Program.

NUREG-1022 provides the following guidance: "If an LER is incomplete at the time of original submittal or if it contains significant incorrect information of a technical nature, the licensee should use a revised report to provide the additional information or to correct technical errors discovered in the LER." FENOC believes that the LER was complete at the time of original submittal and remains accurate. FENOC continues to believe that the current Technical Root Cause Report and Management and Human Performance Root Cause Report provide a comprehensive explanation of the progression and causal factors of the Davis-Besse RPV head degradation event and, hence, contain the most appropriate information to have used in development and implementation of corrective actions to prevent recurrence.

FENOC also considered its obligations under 10 CFR 21, which requires reporting of information if a basic component fails to comply with any applicable rule, regulation, order, or license of the Commission relating to substantial safety hazards or the basic component supplied to such facility or activity contains defects, which could create a substantial safety hazard.

10 CFR 21.21(d)(2) states that the notification to the NRC is not required if FENOC has actual knowledge that the NRC has been notified of the defect in writing. The threshold question is whether the Exponent Report identifies a new "defect" not previously reported to the NRC and that otherwise meets Part 21 reporting requirements. In this case, Part 21 notifications are not required because an LER on the same matter was previously issued on the old reactor

pressure vessel head, and the Exponent Report identified no new substantial safety hazard.

Finally, 10 CFR 50.9(b) addresses licensees' duty to provide the NRC with information that may have "a significant implication for public health and safety or common defense and security." FENOC believes that the information in the Exponent Report does not fall within the scope of this regulation because the Davis-Besse RPV head has been replaced and the enhanced inspection program now required by the NRC at Davis-Besse and all other Pressurized Water Reactors (PWRs) prevent any significant implication for public health and safety. In early December 2006, Exponent concluded and reported that had the current NRC Inspection requirements been in place at the time of 12RFO in 2000, the cracks in the nozzle would have been detected and no head wastage would have occurred. FENOC discussed the impact of the analysis in at least two conference calls with Exponent. In each instance, Exponent stated that its report did not present a safety concern because of the new inspection requirements which would detect cracks like those at Davis-Besse before any significant wastage would occur.

VII. Discussion of Communications

FENOC remained focused on safety throughout its consideration of the Exponent Report. In addition, FENOC's response to the safety concern from NEIL was to enter it into the CAP to ensure the appropriate reviews were completed.

FENOC established early in the process that we did not believe that there were any safety concerns identified in the Exponent Report. However, we recognize that we should have been more sensitive to the regulatory significance of this new information and to the NRC's need to independently determine its significance to the NRC's oversight responsibility.

FENOC recognizes that the NRC's restart approval was based on, among other information, inspection results, root cause determinations and corrective actions, and commitments made both verbally and formally as part of the NRC Manual Chapter 0350 activities. FENOC provided information and commitments as part of the restart regulatory process and further relies on the CAP as the mechanism to evaluate potential safety concerns. In this case, there was no formal interface process between the insurance arbitration process and the nuclear processes. When FENOC became aware of the information in the Exponent Report in December 2006 and determined that no safety issue existed we did not further consider the extent to which we should inform the NRC. In addition, there was no process in place to prompt consideration of communication of a commercial matter to the NRC. FENOC enters potential safety concerns into CAP; since FENOC did not believe that the information in the Exponent Report represented a safety concern, none was entered into CAP.

CAP is a process that is available to the NRC Resident Inspectors to assist them in becoming aware of issues and a forum that facilitates discussion between the station and the NRC Resident Inspectors. This meaningful dialogue did not occur until February 23, 2007. Consequently, this did not enable the NRC to independently assess the significance of the report in parallel with the station.

The safety significance of Exponent's timeline for crack growth and head wastage is low, as determined initially by FENOC, then by an Expert Panel convened by NEI and by the NRC. FENOC's shortcoming was the lack of a process that required consideration of the regulatory significance.

FENOC will develop a formal process to review technical reports prepared as a part of a commercial matter. The process will provide criteria for FENOC to utilize to determine if the report has the potential for regulatory implications or impact on nuclear safety both at our sites and within the nuclear industry. This process will provide for the timely and critical evaluation of this type of report and will complement our existing formal nuclear process for obtaining technical reports from our agents and contractors.

FENOC will also provide an OE document to the nuclear industry through the established OE process. This OE document will discuss the issues surrounding this DFI, including the review of technical reports prepared as part of a commercial matter.

VIII. Clarification of May 2, 2007, Letter

As described in response to Demand B, FENOC has gained a more comprehensive understanding of the Exponent Report as a result of the process undertaken to respond to this Demand for Information. In responding to the NRC's April 2, 2007, Request for Information, FENOC was focused on the Exponent Report's timeline for the crack growth and wastage phenomenon and their impact on the current industry inspection regime. FENOC did not focus on the Exponent Report's overall conclusions and assumptions; therefore, we now recognize our narrow perspective did not fully satisfy the NRC's request.

Specifically, in the May 2, 2007 letter, FENOC stated that;

> FENOC has not specifically evaluated all of the assumptions used by Exponent; however FENOC believes that the conclusions in the Exponent Report reflect a more accurate representation of the timing of the events.

Up to this point, discussions surrounding the Exponent Report were focused on the cracking and subsequent wastage phenomenon. We did not provide our perspective on the overall conclusions and assumptions in the Exponent Report. The FENOC Technical Root Cause Report dealt with the actual wastage in a simplistic analytical manner. Since the Exponent analysis included the discovery of the J-groove weld crack, utilized a detailed computer model, and was based on recently available test data, we believed the Exponent results to be more informed, thus accurate, when compared to the Technical Root Cause report's characterization of the wastage phenomenon.

However, when the overall conclusions and assumptions are considered, we continue to believe the root cause of the RPV head degradation event was our failure to properly implement the BACC program and there is nothing that we have reviewed in the Exponent Report that has changed this conclusion, as will become more evident in our response to Demand B.

In our May 2, 2007 letter, FENOC had no intent to distance ourselves from the commitments made and information used to approve the restart of Davis-Besse. FENOC's narrow perspective became very evident as discussions evolved, both internally, with Exponent personnel; and with the NRC over the last month. Process changes will be made to the NRC Correspondence procedure to ensure specific questions are asked during the process relative to the experience gained from the efforts to respond to this DFI.

IX. Summary

Upon review of the Exponent Report, FENOC management questioned, and received assurance that Exponent had considered and concluded that the current inspection program would have detected the CRDM cracking prior to significant RPV head degradation. The Exponent Report was a product of the insurance arbitration process. NEIL, the insurer, identified a potential safety concern that was put into CAP to ensure the right safety and reportability reviews were completed. Further, personnel were aware of, and addressed, the potential effect of the report's conclusion related to the timeline of the cracking and wastage event on Davis-Besse. However, the information in the report was not thoroughly evaluated for regulatory significance. An additional influential contributor was the early conclusion that there was no safety significance. The FENOC staff believed they had completed their required actions, that is, to assure no safety concern existed, and did not enter the Exponent Report into a formal nuclear review process. As demonstrated above, FENOC believes that there is no regulatory requirement to have reported the information in the Exponent Report to the NRC earlier.

FENOC will develop a formal process to review technical reports prepared as a part of a commercial matter. Regardless of the reasons, FENOC is aware of its responsibility to maintain very strong focus on both the safety significance and the regulatory significance of information of which we become aware. In our May 2, 2007 letter, FENOC did not focus on all of the Exponent Report's conclusions and assumptions; and we now recognize that our narrow perspective did not fully satisfy the NRC's request. We continue to believe the root cause of the RPV head degradation event was our failure to properly implement the BACC program. There is nothing that we have reviewed in the Exponent Report that has changed this conclusion. In addition, we acknowledge our continued responsibility to communicate important information to the NRC, especially regarding issues related to the Davis-Besse head degradation event.

DEMAND B

A detailed discussion of the differences in assumptions, analyses, conclusions, and other related information of the Exponent Report and previous technical and programmatic root cause reports, developed following the 2002 Davis-Besse reactor pressure vessel head degradation event. Your response shall address, among other matters you believe warranted, differences between the operational experience data, such as the origin and presence of boric acid deposits and corrosion products on air coolers, radiation filters, the reactor vessel head, and other components in the containment, and the Exponent Report assumptions for these items. Your response shall also indicate if differences in the Exponent Report assumptions, analyses, information, or conclusions and previous root cause reports demonstrate a need for any new or different corrective actions relative to the 2002 Davis-Besse reactor pressure vessel head degradation event and related issues. Your response shall also address the impact on the continued effectiveness of your corrective actions.

I. Introduction

FENOC's response to Demand B reviews the differences between the Exponent Report and FENOC's root cause reports developed in 2002, in response to the discovery of degradation of the Davis-Besse RPV head.

Based on this review FENOC continues to believe that the current Technical Root Cause Report and Management and Human Performance Root Cause Report provide a comprehensive explanation of the progression and causal factors of the Davis-Besse RPV head degradation event and, hence, contain the most appropriate information to have used in development and implementation of corrective actions to prevent recurrence.

This response also concludes that corrective actions identified through FENOC's earlier root cause efforts were appropriate to the technical and programmatic deficiencies they identified. Although there are differences in the assumptions and analytical methods used in the various reports, the conclusions reached do not present a new safety concern or demonstrate a need for any new or different corrective actions.

Section II of this response describes the method used and actions taken by FENOC to undertake the review. Section III provides discussion on the different purposes for and methods used by FENOC's root cause teams and Exponent in the development of their reports. Section IV provides the requested review of the significant differences between the Exponent Report and FENOC's root cause reports, including discussion of the specific operating experience information specified in Demand B, as well as a discussion of the different event timelines. Section V addresses the need for new or different corrective actions, and effectiveness of existing corrective actions. Finally, Section VI summarizes FENOC's conclusions in regard to Demand B.

II. FENOC's Actions to Respond to Demand B

In order to properly review the Exponent Report and the differences in assumptions, analysis, conclusions and other related information as compared to the Technical Root Cause Report and the Management and Human Performance Root Cause Report developed during the 2002 Davis-Besse head degradation event, FENOC re-assembled several members of the original team that produced the Root Cause Reports in 2002. This was done to ensure the original work was well understood during the review. The review involved comparing the Exponent Report's statements of assumptions, analyses, and conclusions, against the information in the Technical Root Cause Report and, where overlaps existed, mainly in the programmatic areas, the Management and Human Performance Root Cause Report. The Technical Root Cause Report used a simplistic model for the cavity formation and the Exponent Report used an analytical model for the cavity formation. FENOC did not perform a detailed review of the modeling techniques or technical assumptions outside of the operational information and observed data known to FENOC.

In parallel with this review, FENOC asked Exponent to furnish its views with respect to that portion of the DFI calling for review of the differences in assumptions, analyses, information and conclusions. This was provided to the root cause review team for clarity. Subsequently, FENOC invited several principal authors of the Exponent Report to meet with the review team and other members of FENOC's staff to further brief them on their consideration of operating experience information and the bases for their views of these differences. These discussions were informative and were focused on the understanding of these differences and the basis for Exponent's alternative interpretation of operating experience data. Section III and IV discuss the significant differences between the Exponent Report and FENOC's earlier root cause reports and our conclusions regarding those differences.

FENOC's review team also performed a review of corrective actions to analyze the impact of those differences between the Exponent Report and corrective actions from root cause efforts in 2002. The scope of FENOC's review included not only the Technical and Management and Human Performance Root Cause Reports, but also included corrective actions identified by the other principal assessments and root cause reports shown below.

CR 02-00891	"Significant Degradation of the Reactor Pressure Vessel Head" (Technical Root Cause Report or TRC);
CR 02-00891	"Failure to Identify Significant Degradation of the Reactor Pressure Vessel Head" (Management and Human Performance Root Cause Report or MHURC);
CR 02-02578	"Failure in Quality Assurance Oversight to Prevent Significant Degradation of the Reactor Pressure Vessel Head";
CR02-02581	"Lack of Operations Centrality in Maintaining, Assuring, and Communicating the Operational Safety Focus of Davis-Besse and Lack of accountability of Other Groups to Operations in Fulfilling that Role";
CR 02-04914	"Apparent Violation of 10CFR50.9, Completeness and Accuracy of Information"
CR 02-07485	"Company Nuclear Review Board Assessment";
CR 02-07525	"Assessment of Engineering Capabilities";
CR 02-08514	"Evaluation of Corporate Management Issues Arising from Degradation of the Reactor Pressure Vessel Head"
CR 02-04884	"Ineffective Corrective Action Problem Resolution Human Performance and Implementation

III. Differences in Purpose for and Methods Used in Developing FENOC's 2002 Technical Root Cause Report and Exponent's Report

There are key differences in the purpose of the Exponent Report and the root cause reports, the methods each utilized, and information available. The Exponent report is a technical analysis prepared for arbitration in an insurance case to address language in the insurance policy. It also was to address whether or not the wastage cavity that developed at CRDM Nozzle 3 could have been detected in April-May 2000 when Davis-Besse was shut down for 12RFO. The Technical Root Cause Report was prepared to determine the root and contributing causes for the RPV head damage experienced at Nozzle 3 and minor corrosion at Nozzle 2, to support the operability determination for the station's as-found condition and the future repair plan. There are key differences in the purpose of the reports, the methods utilized, and the information base. Further, a "root cause" is meant to be broader in scope and fully address organization and context issues to discover why events occur. This supports establishment of corrective actions to prevent recurrence. Technical Reports are much narrower in scope and typically address when and how events may occur. These differences in purpose and method support FENOC's conclusion that the root cause reports provide a comprehensive event analysis to produce corrective actions sufficient to prevent recurrence of similar events.

A. Root Cause Approach

To understand why the RPV Head Degradation Event occurred requires a structured root cause analysis of the event surrounding the significant damage to the RPV head near Nozzle 3, and of the fact that its development had gone undetected at a time when it was believed that industry understanding of nozzle cracking and leaks had resulted in inspection programs that would prevent damage resulting from those leaks. In the initial development of the timelines for the root cause effort during the extended shutdown, it became clear that since boric acid that had been left on the head had obscured views of the center region, there was no direct visual evidence of the cavity formation and growth. Therefore, other evidence from plant data, interviews, and records was used to construct the timeline. In addition, Figure 26 of the Technical Root Cause Report, Timeline of Key Elements Related to Reactor Vessel Head Boric Acid Corrosion, was constructed to illustrate the coincident factors over the time period of interest. When this information was combined with the body of industry knowledge of PWSCC and boric acid corrosion, it resulted in the determination of the root causes contained in the Technical Root Cause Report.

Specific metallurgical considerations for Nozzle 3 were limited to available physical evidence and fabrication records that provided insights linking it to a heat of material known to be particularly susceptible to PWSCC. At that time, the metallurgical insights and data specific to Nozzle 3 that resulted from more recent work at Argonne National Laboratory (ANL) were not available to the root cause teams.

The root cause team recognized the probability that continued interest in this event would lead to future research, as stated in the "Purpose and Scope of the Root Cause Analysis Report," of the Technical Root Cause Report:

> The findings within this report are expected to invite input from industry experts and scientists resulting in additional study of the evidence, and further research into the topics of CRDM nozzle cracking and boric acid corrosion.

Further, the same report states on page 24;

> Further effort is ongoing to better define the corrosion rates based on the final measured size of the cavity and thermal-hydraulic modeling being performed by the MRP [Material Reliability Program]. Technical insights gained from that effort may provide improved understanding, but are not expected to conflict with the evidential basis for the projections made here.

B. Exponent's Approach

The Exponent Report sought to address the morphology and growth of the wastage cavity, crack growth and nozzle leakage, based principally on calculations and mathematical modeling using inputs from the specific metallurgical data developed by testing of the material taken from Nozzle 3.

Although Exponent considered the same information that was available to the root cause teams in 2002, it was not used in the same way to build its conclusions, as will be explained later. The Exponent report also considered information and data that emerged after the issuance of the Technical Root Cause Report. The most significant of this new information was the BWXT metallurgical examination of the Davis-Besse CRDM Nozzle 3 nozzle, weld, and cavity; the NRC/ ANL crack growth measurements on the Davis-Besse Nozzle 3 Alloy 600 CRDM material; and the NRC/ANL data on the corrosion of low-alloy steels in molten metaboric acid. Exponent also relied on the Electric Power Research Institute's (EPRI) March 2004 revised MRP safety assessment report (MRP-110). This information was not available to the FENOC Root Cause team at the time it prepared its Technical Root Cause Report.

As described in Sections 8 through 10 of the Exponent Report, Exponent first established a timeline for crack growth for the long axial crack at CRDM Nozzle 3. They then developed a timeline for the development of the wastage cavity, based on an analysis of leakage through the axial crack and leakage through the previously unknown weld crack, computational fluid dynamics (CFD) modeling of the thermal hydraulic conditions in the developing cavity, and metal removal mechanisms based on these conditions. With this timeline developed from modeling of empirical data, Exponent then assessed the plant operating experience information to determine whether that experience contradicted that timeline.

C. Comparison of Approaches

The approach used by the root cause teams in 2002 was well suited to the purpose of that review and the data available at that time. As the Technical Root Cause Report noted, that review did not have the benefit of later developed metallurgical information specific to Nozzle 3. Hence, the root causes and corrective actions are not highly sensitive to the metallurgical specifics of the crack progression and wastage. The root cause team looked broadly to available operating experience information to develop its timeline and root causes. In contrast, Exponent had the benefit of metallurgical data developed by ANL and others related to the specific nozzle and used the Technical Root Cause Report as a starting point in their analysis. After developing its timeline based upon modeling of the nozzle-specific data and input assumptions, Exponent reviewed the plant operating experience for contradictory indications. As a technical analysis, FENOC believes that Exponent's work provides supplemental insight into <u>how</u> the metallurgy of crack growth may have proceeded within the RPV nozzles and when the Nozzle 3 cavity itself may have grown in its final stages. However, FENOC still believes that the timeline in the Technical Root Cause Report better approximates the onset of CRDM nozzle leakage and the onset of metal removal based on the fit of the observed operational evidence. FENOC continues to believe that the current Technical Root Cause Report and Management and Human Performance Root Cause Report provide a comprehensive explanation of the progression and causal factors of the Davis-Besse RPV head degradation event and, hence, contain the most appropriate information to have used in development and implementation of corrective actions to prevent recurrence.

Noteworthy differences between the Root Cause and Exponent's event timelines and interpretations of the relevant operational data are discussed in greater detail in Section IV below.

IV. Significant Differences Between FENOC's Root Cause Reports and the Exponent Report

The root cause and Exponent reports are in agreement with respect to the underlying technical cause of the Davis-Besse RPV head degradation event – i.e., that PWSCC of the Alloy 600 CRDM Nozzle 3 resulted in the formation and growth of through wall cracks and boric acid wastage of the head. In this regard, both the Technical Root Cause Report and the Exponent Report agree that crack growth requires time and appropriate nozzle stress conditions. They also agree that minor leakage precedes significant corrosion.

The root cause evaluations and Exponent technical analyses yielded different conclusions relative to the overall timeline associated with the RPV head degradation event. The Exponent Report concludes that leakage from Nozzle 3 occurred over a significantly shorter time period than the approximately 6 - 8 year period discussed in the Technical Root Cause Report. Exponent concluded that leakage progressed over an approximate 3-year period because the crack growth rate in the Nozzle 3 material was determined by test to be up to four times higher than the 75th percentile crack growth rate for Alloy 600 material as described in the text of MRP-55. Additionally, Exponent concluded that the leak rate and boric acid corrosion rate increased suddenly in the October/November 2001 timeframe, when wastage from an axial crack in the CRDM nozzle uncovered a pre-existing crack through the J-groove weld, and again when wastage uncovered the back side of the J-groove weld. The existence of the second crack was not known until 2003.

The Technical Root Cause Report determined that the physical evidence indicated that identifiable nozzle leakage was present in 1996, and that significant corrosion of the head began about 1998. These were important understandings because inspection programs and Technical Specification requirements for zero pressure boundary leakage should have resulted in the determination/correction of the leakage source at that time. In this context, wastage cavity growth would occur after the failure of the barriers intended to prevent it, and consequently is not directly related to the root causes. This understanding led to the associated root cause investigation into <u>why</u> the failure to identify the degradation of the RPV head occurred.

The different timelines reflect, in part: (1) different interpretations of plant operating experience data, and (2) differences in FENOC's and Exponent's assumptions, analyses, and conclusions regarding crack growth rates, nozzle leakage, head wastage and cavity formation. We discuss these differences below.

A. Differences in Consideration of Operating Experience Information

To assess the differences in each category of operational experience information identified below, we discuss the conclusions regarding that information in the root cause reports, Exponent's conclusions regarding that information, and FENOC's views regarding their respective conclusions.

1. Boric Acid on the RPV Head and CRDM Flange Leakage

a. Root Cause Consideration

Historically, Babcock and Wilcox (B&W) designed plants experienced problems with CRDM flange leaks. It was not unusual for these leaks to be accompanied by boric acid deposits on top of the insulation and down onto the RPV head. To address this problem, Davis-Besse replaced the existing CRDM flange joint components with graphite/SST gaskets over the course of five refueling outages (6RFO through 10RFO). During that period, flange leaks continued, but eventually declined. In 1991 (7RFO), 22 CRD flanges were determined to be leaking, of which 15 were repaired. The RCS Engineer reported an excessive amount of boric acid on the RPV head in this outage. In 1993 (8RFO), 15 CRD flanges were determined to be leaking. Boric acid deposits were dripping through the insulation forming stalactites, and started forming stalagmites on the RPV head. Additional boric acid deposits were clinging to the side of the CRDM nozzles. The RPV head was then cleaned with deionized water, although the effectiveness of the cleaning could not be verified by the root cause team.

While many pieces of operational experience data contributed to the timeline and conclusions in the Technical Root Cause Report, the framework upon which the root cause relied included the observed changes in boric acid accumulations on the reactor head after 9RFO (1994). The credible sources of boric acid deposits in the RPV head regions were CRDM flanges, which had leaked historically, and CRD nozzle leaks, which had become an industry concern. Based on reviews of the head and CRDM inspection videos, condition reports, and other evidence discussed below, the Root Cause team concluded CRD nozzle leakage had begun by 1996 and continued through ensuing operating cycles, resulting ultimately in the severe head degradation near Nozzle 3 that was discovered in 2002. The conclusions of the Technical Root Cause Report were based on the following considerations:

- The number, location, and severity of CRDM flange leaks found in each refueling outage;
- The quantity, appearance, location, and physical attributes of boric acid accumulations found on the reactor head in each refueling outage;
- The quantity, appearance, location, and physical attributes of the boric acid accumulations found on top of the insulation above the head; and

- Evidence of new boric acid accumulations or staining on the underside of the insulation and sides of nozzles.

In 1994 (9RFO), eight CRDM flanges were identified as leaking and were repaired. None of these flanges was located near the center of the head. The CRDM flanges were inspected, and there were no reports of boric acid deposit interference problems with the inspection equipment. However, there were no records identified indicating either that a visual inspection or cleaning of the RPV head was completed.

In 1996 (10RFO), boric acid deposits were visible at the top center region of the head around the centermost nozzles and estimated to extend up to the bottom of the mirror insulation. These deposits were powdery and white, and thin at the front edge, with powder and small clumps on top. Also, the underside of the insulation did not show crusted boric acid deposits or stalactites, as had been seen in prior cases involving significant flange leakage. Because only one minor flange leak was reported in 10RFO, the accumulation at the top of the head was not consistent with the reported flange leakage. The majority of the RPV head was reported to have been inspected (with the exception of the top center region) and found to be generally clean. Some "speckles" of white boric acid deposit were observed. Also, some rust or brown-stained boric acid was noted in the area around nozzle 67, which is located on the periphery, i.e., away from the area of significant degradation discovered in 2002. In light of this and later evidence, the root cause team determined that a nozzle leak existed by 1996.

In 1998 (11RFO), only Nozzle 31, which is near the periphery and downhill, was identified to have a minor flange leak, and was determined to not require immediate repair. However, the as-found accumulation of boric acid on the head extended from the top of the head to the inspection ports (mouse holes) in the southeast quadrant. The Technical Root Cause Report indicates it encompassed an area around 19 nozzles, and had grown at the top of the head toward the northwest quadrant. There were no reports of boric acid bridging to adjacent flanges, no stalactites hanging from flanges, no boric acid hanging from the insulation, and no interference from boric acid accumulation on top of the insulation during the visual inspection of the control rod drives. However, boric acid was identified flowing out of the mouse holes in the southeast quadrant of the RPV head flange, and it was a reddish rusty color. Boric acid was also collecting behind peripheral nozzles. The conclusion was that this much boric acid in the locations present was leakage from Nozzle 3, which was adjacent to the large cavity discovered in 2002. It was located near the top of the head in the southeast direction from the top center of the head.

In 1999 (mid-cycle outage), a limited number of CRDM flanges were inspected. No CRDM flange leakage was reported. It should be noted that during operating cycle 12, boric acid began accumulating on the CACs and filters for the radiation elements. Early in this operating cycle, a Pressurizer Relief Valve was found to be leaking and was thought to be coinciding with this accumulation. However, following repair of this leak during this mid-cycle shutdown, two additional CAC cleanings were required. Also, after the mid-cycle outage, radiation element filters began plugging with boric acid deposits in March 1999, and by May 1999, the boric acid deposits on the filters had developed a yellow or brown appearance. Results from sample analysis in 1999 indicated that the fineness of the ferric oxide particles suggested that it was attributable to a steam leak.

In 2000 (12RFO), FENOC observed that boric acid accumulated on the RPV head flange behind the studs and flowing out of the mouse holes in the southeast quadrant. It had a red, rusty appearance, and mouse holes in the southeast quadrant were significantly blocked with boric acid deposits. Based on CRDM flange inspection, five nozzle flanges were repaired (one known leaking flange (31) and four possible leaking flanges (3, 6, 11, and 51)), all in the southeast quadrant. The flange for Nozzle 31 (near the periphery of the RPV head) was machined to remove a steam cut from the seating surface. Interferences from boric acid deposits on top of the insulation were in the general vicinity of the reported flange leaks. While some of the boric acid deposits may be attributable to flange leakage, additional factors support that leakage and corrosion at Nozzle 3 must also have been a source of these deposits. Boric acid on top of the insulation was a red, rusty color and hard. Normally, boric acid found on top of the insulation is a loose powder and in the color range from white to yellow. The underside of the flange at Nozzle 3 was caked with red boric acid deposits (nearly a year after iron oxide began appearing in radiation element filters), and there were no boric acid deposits on the vertical faces of the flange. The as-found area of boric acid deposits on the RPV head had grown significantly wider since the previous outage. These indications were compared to the earlier RPV conditions in 1998, which showed that nozzle leakage was in progress then, and the later RPV conditions in 2002 of extensive rust-colored boric acid deposits, a large cavity at Nozzle 3, and no CRDM flange leakage. From this, it was concluded that corrosion had been occurring at a rate sufficient to have created observable damage to the RPV head in the region of Nozzle 3 by 12RFO.

Plant conditions during cycle 13 continued to include fouling of containment air coolers and iron oxide deposits in radiation filter elements, and the final corrosion cavity was found in early 2002.

In 2002 (13RFO), FENOC identified no CRDM flange leakage, an indication that previous repairs had been successful. However, boric acid was piled high near Nozzle 3 above the insulation, making the inspection of the underside of the flange difficult. There were reports of other significant piles of boric acid under the RPV head insulation.

b. Exponent Consideration

The Exponent Report presents a different interpretation of the operational evidence discussed above. Exponent attributes the pre-2002 boric acid deposits on the RPV head to CRDM flange gasket leakage (as opposed to nozzle leakage).

Exponent's supporting justification is essentially three-fold. They are (1) such original supplied gaskets were known to leak at other Babcock & Wilcox plants; (2) Davis-Besse had experienced leaking CRDM flange gaskets in the 1990s; and (3) gaskets on five flanges required replacement at 12RFO due to reported flange gasket leaks.

Exponent acknowledges that red deposits result from the incorporation of iron corrosion products into boric acid, and concludes that the cause of such red boric acid deposits at Davis-Besse prior to Cycle 13 was general corrosion of the RPV head from boric acid deposited by earlier CRDM flange leakage. Exponent attributes the observed flow of boric acid toward the weep holes to the transformation to molten metaboric acid at operating temperature. Exponent also notes the absence of evidence that boric acid from leaking CRDM flanges prior to 1994 was effectively cleaned from the reactor head and that there is no record of head cleaning or inspection from 9RFO in 1994.

With respect to 12RFO, Exponent noted that Nozzle 31, found with minor leakage in 11RFO but not repaired, continued to leak until 12RFO and leakage increased sufficiently to steam cut the CRDM flange. Additionally, Exponent noted that the contemporaneous condition reports from 12RFO noted that four additional flanges were observed to have leakage and their gaskets were replaced. The leakage was not quantified. Finally, as described on pages 10-8 and 10-9, Exponent concluded that the small leak (0.0004 gpm) due to a crack extending above the J-groove weld in Nozzle 3 resulted in metal removal and the possibility of a slight enlargement of the annular gap during Cycle 12, yet was still undetectable with the "through-the-mouse-hole" visual inspection technique.

The Exponent Report concludes that because its technical analysis indicates that leakage from the axial crack at CRDM Nozzle 3 did not become significant until after 12RFO, red boric acid deposits observed prior to that time likely came from other sources. In our subsequent discussions with Exponent, it has been clarified that they conclude limited leakage, on the order of 0.0004 gpm, began in mid-1999.

c. Discussion and FENOC's Conclusions

The key differences appear to relate to the different approaches taken. The Root Cause analysis began with a collection of the operating experience, interviews, and records and reached conclusions about development of the crack, leakage and head wastage. Exponent, in contrast, began with evidence of the head wastage, the nozzle crack, and crack growth rate in the metal specimen and calculated the expected leakage and considered the resulting physical conditions one would expect to observe.

The different conclusions set forth in Exponent Report do not convince FENOC to alter its conclusion relative to when nozzle leakage began on the RPV head, and, consequently, when it should have been observed and corrected. The following excerpt from the Technical Root Cause Report continues to represent FENOC's conclusions regarding the source of boric acid deposits on the Davis-Besse RPV head:

> It is considered that most of the boric acid deposits found on the Davis-Besse RPV head at 13RFO have come from leaking nozzle 3 with potential contributions from nozzle 2. The basis is that the vessel head was reported to be clean at 9RFO, significant boric acid deposits had appeared on the vessel head by 11RFO, there were no significant gasket leaks prior to 11RFO, experience in the industry does not suggest that leakage from the nozzle 31 flange gasket would have resulted in extensive deposits on the vessel head at 12RFO, and additional deposits appeared during cycle 13 when there were no reported flange leaks. The source of the deposits is further supported by the reactor head boric acid sample results . . . .

The Exponent Report relies on the existence of prior deposits and new leakage from Nozzle 31 to explain the boric acid deposits present in 1998. However, based on the downhill location of Nozzle 31, its reported minor leak, and the evidence of the size of boron deposits on the head from prior outages, FENOC believes that the root cause analysis continues to provide the most appropriate explanation for the source of the boric acid accumulations.

The Technical Root Cause Report timeline for nozzle leakage and head corrosion is based on observed increases in boric acid accumulation on the RPV head over several plant operating cycles beginning in 1996 and supported by the other operational conditions discussed. Regardless of the number of nozzles obscured in 1996, the quantity of boric acid observed increased each outage despite the replacement of all flange gaskets by 10RFO (1996). FENOC's Technical Root Cause Report describes how boric acid began to accumulate on the RPV head due to nozzle leakage. It also details other physical evidence in the period between 1996 and 2000 that supports the reasonableness of the timeline developed in the Technical Root Cause Report and the conclusion that leakage from CRDM nozzles would have been detected prior to 12RFO had Davis-Besse personnel properly implemented the BACC program.

2. Fouling of the Containment Air Coolers

a. Root Cause Consideration

The Containment Air Coolers (CACs) are subject to fouling by boric acid entrained in the containment atmosphere whenever an RCS steam leak exists. The Technical Root Cause Report notes that during the 12th cycle (1998 to 2000), the CACs clogged frequently. From November 1998 to April 1999, Coolers 2 and 3 were each cleaned 17 times. In cycle 13 (2000 to 2002), CACs required cleaning nine more times (5 times in 2000 and 4 times in 2001.

The Technical Root Cause Report noted that while CAC fouling appeared to be associated with a flange leak on a steam generator in 1992, previous incidents of CRDM flange leakage had not resulted in the need to clean CACs. The root cause concluded that:

> Attributing the need for CAC cleaning to leaking CRDM nozzles is plausible, but has several inconsistencies that would need to be explained. The most prominent is that if nozzle leakage continued on an increasing trend from May 2001 until February 2002, why did the need to clean the CACs end in May 2001?

The root cause analysis acknowledges that the history and timing of CAC fouling is not alone indicative of a leak at Nozzle 3, but does not contradict the other more significant indications of the progression of nozzle leakage and head degradation.

> In summary, there was circumstantial evidence that CAC fouling was related to nozzle leakage prior to 13RFO. Because of variations in plant conditions, CAC fouling, by itself, could not be directly correlated with CRDM nozzle leakage.

b. Exponent Consideration

The Exponent Report recognizes that CAC cleaning rapidly declined to zero in April-May 2001 and relates it coincidentally to Exponent's conclusion that cavity growth changed about this time to accelerate downward. The Exponent Report attributes the frequent need to clean the CACs during the previous operating cycle (1998-2000) to a leak from a pressurizer safety valve. Exponent associated the two additional CAC cleanings that occurred after the completion of a plant shutdown during which the relief valve leak was repaired to the previous leak.

c. Discussion and FENOC's Conclusions

Overall, it appears that neither the Exponent Report nor FENOC's root cause analysis directly correlates CAC cleaning with the timeline. Both allow that CAC cleaning may be associated with nozzle leakage in 2001 and with leakage from a pressurizer relief valve prior to mid-cycle outage repair in 1999. Two cleanings were required after the pressurizer relief valve repairs. Therefore, the observed need for CAC cleaning indirectly supports the conclusions regarding the timeline of events presented in Technical Root Cause Report.

3. Fouling of the Containment Radiation Monitor

a. Root Cause Consideration

The Technical Root Cause Report indicates that immediately following the mid-cycle outage in 1999, the containment atmospheric radiation elements began clogging and soon exhibited red-brown colored particulate. Analysis of this material identified the presence of iron oxide and boric acid. There were 83 filter replacements in the first 2-1/2 months following the mid-cycle outage. To address this, large HEPA filters were added to containment, but were ineffective in stopping the need to replace the radiation monitor filter elements. Analysis concluded that the particles were likely from a steam leak high in containment. This indicated that the source of leakage was likely a hot pressurized, borated system in a location at which the leakage could damage carbon steel. Further the suction locations for normal sampling are located high in containment, and the ventilation exhaust from the reactor head region would be expected to communicate with this area. Iron oxide accumulation in the filters persisted during the following operating cycle. Red boric acid deposits were identified on the underside of the Nozzle 3 flange during 12RFO. In 13RFO, a material sample taken from the underside of the flange for Nozzle 3 was found to be mostly iron borate, which supported the root cause determination that this evidence was related to the iron oxide that was accumulating in the radiation monitor element filters.

b. Exponent Consideration

The Exponent Report (Section 7.2.2) discusses the noble gas and iodine radiation monitor readings inside containment in the October-November 2001 timeframe. The report states that the significant increase in noble gas radiation levels in mid-Cycle 12 (May 1999) was associated with the pressurizer relief valve leakage. It also notes that although the radiation detectors are effective in identifying a rapid change in leakage, they tend to constantly accumulate particulates in containment over the course of a fuel cycle, giving a continuously increasing detector response that is difficult to distinguish from subtle changes in leakage, and that the output also fluctuates with filter changes. Exponent reasons that there is no means to easily distinguish CRDM nozzle leakage from any other RCS leakage, and that RCS leakage could still mask the relatively small leakage expected from a CRDM nozzle leak. Therefore, Exponent states that the particulate detector does not provide a good measure of possible long-term CRDM nozzle leakage. In our subsequent discussions, Exponent noted that the nozzle crack reached the top of the J-groove weld and thus even though no fluid jet cutting would be present, metal removal by metal corrosion, albeit slight, due to the high-velocity steam likely began in mid-1999 from an estimated leakage of 0.0004 gpm.

c. Discussion and FENOC's Conclusions

The Exponent Report and the Technical Root Cause Report seem to agree on the potential relationship of nozzle leakage to iron oxide in the containment atmosphere, in that the Exponent Report states that the potential for plugging of the 0.3 micrometer filter paper can be a strong indication of the beginning of RPV head wastage due to the energetic process associated with RCS leakage. Exponent appears to credit other sources of iron oxide without identifying their source. Therefore, the Exponent discussion related to a slight metal removal from a 0.0004 gpm leak possibly causing iron oxide to reach the radiation monitor filter elements is not an explanation that causes us to modify our Technical Root Cause Report.

The evidence of iron oxide in the radiation monitor filters in May 1999 is one of the more significant differences in the two reports. Exponent's report predicts that the Nozzle 3 crack would be just above the weld at that time, resulting in only sub-surface wastage, and the accumulation of less than 1 cubic inch of boric acid on the RPV head a year later in 12RFO. FENOC believes that the plugging of the radiation monitor filters with boric acid and iron oxide in 1999 and later was caused by leakage from Nozzle 3. This stems from the recognition that the deposits on the filter were recognized to be symptomatic of RCS leakage, that the red boric acid deposits obtained from under the CRDM flange for Nozzle 3 were found to be primarily iron oxide, and that red boric acid deposits had been identified under the flange in 12RFO in 2000.

4. Indications of Unidentified RCS Leakage

a. Root Cause Consideration

Prior to the Pressurizer Relief Valve leakage that occurred in 1998/1999, unidentified RCS leakage averaged around 0.05 gpm or less. Following the repair of the relief valve in the 1999 mid-cycle outage, unidentified leakage never returned to similar low levels. This correlated with other evidence that leakage at Nozzle 3 may have increased in 1998/1999. The Technical Root Cause Report also recognized an increase in October 2001, which it related to possible changing conditions on the crack in Nozzle 3.

b. Exponent Consideration

Exponent's work and conclusions with regard to the leak rate from the CRDM Nozzle 3 weld crack, and the dependence of the leak rate from the axial cracks on crack length above the CRDM nozzle weld are summarized in Section 9.4 and Appendix D of the Exponent Report. In section 9.4, Exponent makes an assumption that all leakage above the baseline unidentified leakage of 0.03 gpm is attributed to CRDM nozzle leaks. This amount is 0.17 gpm, which is carried into their fluid modeling calculations and reasoning.

c. Discussion of FENOC's Conclusions

While not directly correlated, RCS unidentified leakage data provided additional evidence, in aggregate with the other evidence discussed, that Nozzle 3 leakage increased in 1998/1999 and was likely masked by higher leak rate from the

Pressurizer Relief Valve. One item to note is that the Exponent Report assumes that all leakage above the baseline leakage is attributed to the nozzle cracks. Although the leakage numbers are not significantly inconsistent with the Technical Root Cause Report, the development of the actual timeline in the root cause for the RPV head degradation event is not highly dependent on the unidentified leakage rate. Due to unidentified leakage being key data, the Exponent Report conclusions carry the uncertainty of the leakage source and rates into the fluid dynamic model. Additional uncertainty is carried forward in the Exponent Report's assumption that the leakage coming from Nozzle 2 was 180° away from the "random and indeterminate" interference fit that was key in creation of the wastage cavity. As can be seen, uncertainty in both reports' use of RCS unidentified leakage is not quantified and must be considered in conjunction with other data to draw a reasonable conclusion of the conditions inside containment leading up to the discovery of the head wastage in 13RFO.

B. Differences in Other Assumptions, Analyses and Conclusions

1. Timeline for Crack Growth, Nozzle Leakage, Head Wastage and Cavity Formation

a. Root Cause Consideration

The Technical Root Cause Report team had limited metallurgical data available to it. As stated earlier, the root cause analysis was based principally on operating experience evidence, records, and interviews. Crack growth rates and cavity damage progression were examined only to the extent the available evidence could be correlated to the then-current industry knowledge. The following excerpt from the Technical Root Cause Report summarizes how crack growth rate was considered:

> Based on the visual inspections of the Davis-Besse RPV head, containment air cooler cleaning frequency, interviews, etc., a reasonable time-frame for the appearance of leakage on the RPV head at Davis-Besse is approximately 1994-1996. Utilizing an average PWSCC crack growth rate of approximately 4 mm/year (reference 5.9) through the 16 mm (0.62 inch) thick CRDM nozzle material, the time-frame at which crack initiation occurred would correspond to approximately 1990 ± 3 years. This is a reasonable approximation to the more detailed type of

> calculations performed by the B&WOG [Babcock and Wilcox Owner's Group] in the safety assessment .... (section 3.2.1, p. 18 of TRC)

and,

> The mechanism of PWSCC is not completely understood, and prediction of crack initiation time has proven to be difficult, if not impossible. (section 3.1.1, p. 10 of TRC)

The Technical Root Cause Report provided this information on crack growth because it is integral to understanding the sequence of events, but also acknowledged the limitations on quantifying crack growth rates.

Cavity growth, in turn, is presented in the Technical Root Cause Report in the context of a "'viable' progression of events." Thus, to facilitate some reasonable understanding of the sequence of events, the root cause team necessarily made certain assumptions regarding corrosion rates, within the context of the physical evidence that supported it. As the Technical Root Cause Report states:

> Review of the sequence of relevant events in Attachment 2 [Sequence of Relevant Events] suggests that the corrosion rate began to increase significantly starting at about 11RFO and acted for a four year period of time. With the maximum corrosion length of about 8 inches between nozzles 3 and 11, the average corrosion rate would be about 2.0 inches/year. As a bounding assumption, if the rate increased linearly with time, the maximum corrosion rate near the end of Cycle 13 would be about 4.0 inches/year. The rates growing laterally from the main axis of the cavity would be about half of the rates growing axially, or 1.0 to 2.0 inches/year.
>
> Figure 25 from the Boric Acid Corrosion Guidebook, Revision 1 (reference 5.3) summarizes the available test data regarding boric acid corrosion. These data show that most of the data points for borated water dripping onto hot metal surfaces, impinging onto hot metal surfaces, or leaking into a heated annulus, are in the range of 1.0 to 5.0 inches/year. This is

> consistent with the observed conditions. (Section 3.2.4, p.24 of TRC)

and,

> What made Davis-Besse's situation different were the lengths of the cracks (and associated leaks) and the length of time the leaks went undetected. Ultimately, since the leakage appears to have continued for at least 3 to 4 years, boric acid would have accumulated sufficiently during this period to have provided the necessary environment to begin significant RPV head corrosion. (Section 3.6, p.51 & 52 of TRC)

The Technical Root Cause Report concluded that through-wall leakage had been occurring since about 1996. Having gone undiscovered for six years, the physical progression of the cavity corrosion was not well known. Section 3.2.4 (p. 25) of the report acknowledges that "a detailed description of the damage progression including precise physical mechanisms with a quantitative breakdown of the relative importance of each mechanism would be speculative."

b. Exponent Consideration

The Exponent report evaluates the crack growth rates and leak rates for the CRD Nozzle 3. In addition, Exponent develops computational fluid dynamics calculations to evaluate the thermal hydraulic conditions in the developing wastage cavity and the enhancement of metal removal rates due to reactor coolant system leakage. This work reaches conclusions as a result of new metallurgical data, new analysis of crack growth rates for Nozzle 3 material by ANL, and new research on the corrosive nature of metaboric acid. The report considers plant operational data in the context of the result of these analyses. The report also evaluates crack sizes, leakage rates, damage mechanisms, and boric acid formations over time. It also includes the evaluation of the effects of an additional weld crack that was unknown to FENOC's root cause team in 2002, because it had not yet been discovered. The existence of this crack, combined with other factors, such as changes in the plant's unidentified leakage rate late in cycle 13 were determined by Exponent to support analyses that demonstrate significantly accelerated cavity growth in the last 4 months prior to 13RFO. It also concluded that the amount of boric acid that would be deposited on the RPV head from this leak would have been miniscule in 12RFO.

c. Discussion and FENOC's Conclusions

As discussed above, the Exponent Report provides a timeline of events that is not entirely consistent with the conclusions of the FENOC root cause analysis for the period from 1996 through 2000 (i.e., as to when nozzle leakage first commenced). FENOC respects the technical sophistication of the Exponent Report, but maintains that the physical event is best explained through objective evaluation of the physical evidence, as was done in the root cause analyses. FENOC further believes that mathematical modeling is an important tool, but as with any analytical model, it contains inherent uncertainties that are difficult to estimate from the finished product. Therefore, because of its close relationship to the metallurgical aspects of the cracks and crack growth, FENOC believes that the Exponent Report is useful as a study of the potential for accelerated cavity growth at nozzle 3 near the end of cycle 12. FENOC believes that modeling uncertainties could have a significant impact on conclusions regarding when identifiable leakage from the nozzle would be present. FENOC continues to believe that the current Technical Root Cause Report and Management and Human Performance Root Cause Report provide a comprehensive explanation of the progression and causal factors of the Davis-Besse RPV head degradation event and, hence, contain the most appropriate information to have used in development and implementation of corrective actions to prevent recurrence.

Boric Acid Corrosion Control Program

A short discussion of the BACC is warranted to provide the perspective of the Technical Root Cause Report to the regulatory issues of the time. FENOC's root cause analyses concluded that implementation of the BACC program was inadequate, and discussed specific weaknesses in content and execution. Exponent reviewed FENOC's BACC procedures against the requirements of NRC Generic Letter (GL) 88-05, and found the procedures met the requirements of GL 88-05, but Exponent did not discuss the effectiveness of FENOC's implementation.. FENOC's root cause analyses focused on factors for which FENOC was responsible. Therefore, FENOC's program was not directly compared to others in the industry. Similarly, the NRC's role as external oversight was not relevant in examination of what FENOC should have done, nor what it should do to prevent recurrence. Hence, Exponent's assumptions, analysis and conclusions regarding FENOC's performance in its BACC program are viewed as Exponent's opinion. FENOC maintains that its performance in the BACC program was inadequate, and was a root cause in the RPV head degradation event.

V. Consideration of Corrective Actions

In addition to analysis of the technical differences, FENOC also analyzed the possible impact of the Exponent Report's conclusions on corrective actions developed as a result of the Davis-Besse head degradation event from these root cause reports and the other significant self assessments following that event. The corrective actions were reviewed in light of both the conclusions in the Exponent Report and the issues leading up to the issuance of this DFI. The relevant root cause reports and assessments considered are listed in Section II above.

A. Need for New or Different Corrective Actions

In light of our Response to Demand B, FENOC's review of the differences in the assumptions, analyses, information, and conclusions in the Exponent Report and our root cause reports did not demonstrate a need for any new or different corrective actions relative to the 2002 Davis-Besse reactor pressure vessel head degradation event and related issues.

B. Continued Effectiveness of Corrective Actions Previously Identified

FENOC performed a review of the conclusions in the Exponent Report against the corrective actions associated with these root cause reports and assessments performed in response to the Davis-Besse RPV head degradation event. This review determined that these corrective actions remained effective, with the exception of one issue. Specifically, FENOC's policy on Regulatory Communications will be assessed for potential enhancements through CAP. Additionally, though not associated with the content of the Exponent Report, it is recognized that the May 2, 2007 response to the April 2, 2007 NRC Request for Information was narrow in scope and resulted in unintended conclusions relative to FENOC's regulatory position. This will be addressed through the Corrective Action Program.

VI. Review of Principal Conclusions

This section includes principal conclusions from the Exponent Report in bold, followed by FENOC's perspectives on these conclusions. We now believe that this is the information that the NRC was requesting in the April 2, 2007 letter that requested our perspective on the overall conclusions and assumptions in the Exponent Report.

Section 1 of the Exponent report contains the following global conclusion statement:

1. **We [Exponent] conclude that at 12RFO in April-May 2001 (sic – 12RFO was in April-May 2000), the incipient forming sub-surface wastage cavity at Nozzle 3 would not have been found even if the RPV head had been completely cleaned of boric acid deposits, because at that time boric acid accumulation from the very low leak rate would have been miniscule.**

Response: Later in the Exponent report, this statement is given additional context, in that it is believed that the boric acid accumulations from CRDM flange leaks would have prevented the identification of the small amount (less than 1 cubic inch) of boric acid that would have been present at nozzle 3. Throughout the response to Demand B, FENOC describes why it affirms that nozzle leakage was observable prior to 12RFO, and how implementation of the BACC program should have successfully prevented the damage to the RPV head. FENOC maintains that nozzle leakage and RPV base metal corrosion would be observable and therefore detectable in 12RFO, had the head been completely cleaned.

Section 2 of the Exponent Report contains the Principal Conclusions and Opinions of the work

2.1 **The discovery of the wastage cavity in the Davis-Besse RPV head and the subsequent industry response both show that this event was totally unexpected, unanticipated and unforeseeable.**

Response: The technical root cause report also considers the formation of the large wastage cavity to be unique, as evidenced by the ensuing specific root cause investigation into the failure to identify significant degradation of the reactor pressure vessel head. At the time of the original root cause report, leaks had been discovered from at least 30 CRDM nozzles at PWRs in the United States. None of these plants reported loss of material due to general corrosion that was similar to Davis-Besse Nozzle 3. While the material susceptibility and damage progression may have been unique to Nozzle 3, it did not change the fact that evidence of leaks should have led to actions to prevent the resulting damage. One of the root causes was determined to be that personnel did not comply with the boric acid corrosion control procedure and inservice inspection program, including failure to remove boric acid from the RPV head and to inspect the affected areas for corrosion and leakage from nozzles.

2.2 The nuclear industry and regulatory focus of concern, both US and worldwide, for CRDM nozzle cracking, was on the safety issue of circumferential cracks and possible ejection of a CRDM nozzle, which results in a breach of the reactor coolant pressure boundary and a loss-of-coolant accident (LOCA). Significant CRDM nozzle axial cracking leading to RPV head wastage was not foreseen and was not considered either plausible or a safety issue until the Davis-Besse event.

Response: FENOC believes that this statement represents the opinion of Exponent, and is not reflective of the root causes of the damage to Davis-Besse's RPV head. The FENOC Root Cause Reports support a conclusion that the magnitude of the leakrate and resultant damage were unexpected. The root cause also concluded that the leak should have been found early enough to prevent significant damage.

2.3 The industry and regulatory focus of concern, both US and worldwide, for boric acid leakage was on the wastage of external components and fittings due to boric acid corrosion, and most of the industry research and effort was directed towards the detection and quantification of this type of corrosion, which was readily detectable by means of visual inspection at refueling outages. Significant RPV head wastage was not foreseen and had not occurred until the Davis-Besse event.

Response: The FENOC Root Cause considered the wastage to be unexpected when discovered, but corrosion due to boric acid leaks was not a new phenomenon. While the Nozzle 3 wastage was unprecedented in the industry, the FENOC Root Cause found physical evidence supporting the conclusion that leakage had been present for several operating cycles. As noted in the Exponent Report, "Following the issuance of Generic Letter 88-05 by the NRC in 1988, the US nuclear industry led by Owners Groups and EPRI developed "Boric Acid Corrosion Control (BACC) programs and procedures to detect boric acid leakage before significant wastage occurred." Failure of FENOC to maintain or implement an adequate Boric Acid Corrosion Control program was a direct cause of the head wastage progressing to 13RFO. The Root Cause report also did not consider the rate of progression of the wastage to be crucial for the cause of the event, since it was determined that the degraded conditions (i.e. leaks leading to corrosion) should have resulted in finding/repairing the leaking nozzle prior to significant degradation.

2.4 FENOC's response to industry and regulatory concerns about both CRDM nozzle cracking and boric acid corrosion was both responsible and was in accordance with industry recommendations and regulatory requirements.

Response: Both the FENOC Technical Root Cause and Management Root Cause concluded the Davis-Besse Boric Acid Corrosion Control program was not satisfying the regulatory requirements associated with GL 88-05, and the Technical Root Cause also noted the ISI program was less than adequate. Furthermore Davis-Besse responded to GL 97-01 endorsing BAW-2301, which required boric acid visual inspections in accordance with GL 88-05. These were not performed for 100% of the RPV head surface. As demonstrated by Oconee, even minute amounts of boric acid were detectable in that era when an effective boric acid corrosion control program was implemented.

2.5 PWSCC crack growth rates (CGRs) assumed in the FENOC Root Cause Report were apparently based on the EPRI industry averaged curve. CGR measured in recent tests for the NRC by Argonne National Laboratory (ANL) on samples of actual Alloy 600 from Davis-Besse CRDM Nozzle 3 are three to four times faster than the industry curve predicts. The fact that the CGR for Nozzle-3 Alloy 600 material is nearly four times that assumed by FENOC for the Davis-Besse event analyses means that the crack growth and the development of the large wastage cavity at CRDM Nozzle 3 occurred over a much shorter period of time than previously estimated.

Response: The results of the Argonne National laboratory testing were not available to the Root Cause effort. The Root Cause utilized an average PWSCC CGR obtained from a proprietary EPRI document of 4 mm/year. The CGR was used to approximate when the crack initiated after the root cause used empirical evidence to determine the leak was present as early as 1996. From video inspections of the RPV head, containment air cooler cleaning frequency, interviews, etc., the root cause team concluded that a reasonable time-frame for the appearance of leakage on the RPV head at Davis-Besse was approximately 1994-1996. If the team had applied a faster CGR, it would have estimated crack initiation to have occurred correspondingly later (before 1996 but later than 1990 as projected in the original report.) FENOC agrees that the technical root cause team could not have had the insights regarding CGR for Nozzle 3, because the metallurgical support for it did not exist in 2002. Even today, FENOC believes that PWSCC characteristics experienced in the industry are in fact highly variable.

2.6 Detailed modeling and analysis of the thermal hydraulic conditions in the CRDM annulus has been performed by means of a Computational Fluid Dynamics (CFD) code. CFD analyses have been performed for a range of flows, crack sizes and wastage cavity sizes that cover the range of possible conditions from very low leakage rates into the initially tight cavity, through the crack sizes and leak rates existing at Nozzle 2 in 2002, up to the final large cavity, crack size, and leak rate that existed for the crack at Nozzle 3 in March 2002 crack. These analyses show that thermal hydraulic conditions of velocity, temperature, and wetness develop that can result in extremely high metal wastage rates in the cavity.

Response: The FENOC technical root cause team did not attempt to perform sophisticated flow modeling to predict how cavity growth may have progressed. The root cause team relied on the physical evidence and the contemporary body of knowledge of boric acid corrosion to estimate boric acid corrosion rates at Nozzle 3 to be potentially as high as 4 inches/year near the end of Cycle 13. While not as high a rate as determined through Exponent's modeling, the FENOC root cause analysis conclusions bound the possibility that cavity growth could have accelerated shortly before the cavity was discovered. FENOC affirms that the physical evidence, interviews, and records continue to support the conclusion that failure to properly implement the boric acid corrosion control program in 2000 and earlier resulted in the damage to the RPV head, regardless of how cavity growth may have accelerated late in its formation.

2.7 By April-May 2001, the nozzle crack had grown to the point where aggressive metal removal conditions developed at the bottom of the wastage cavity. Between May and October 2001, the downward growing wastage cavity intersected with the upward growing crack. This resulted in a significant change in the thermal hydraulic conditions in the wastage cavity such that extremely high rates of erosion/corrosion occurred, leading to the large cavity found in March 2002.

Response: The Exponent Report describes an eightfold increase in RCS leak rate as the result of uncovering a large 0.7 inch-long J-groove weld crack at the same location as the nozzle crack. The FENOC Technical Root Cause team was unaware of this J-groove weld crack during their analysis, but did suggest the increased unidentified leak rate may have been due to a changing condition at the crack in Nozzle 3, which is a comparable deduction. However, Exponent's conclusion is in the context that all detectable corrosion occurred after 12RFO, whereas FENOC maintains that the physical evidence shows that observable corrosion was present in 2000, and leakage was observable prior to 2000.

VII. Summary

FENOC re-assembled several members of the original team that produced the Root Cause Reports in 2002. This was done to ensure the original work was well understood and that underlying reasoning was maintained during the review. The review involved comparing the Exponent Report's statements of assumptions, analyses, and conclusions, against the information in the Technical Root Cause Report and, where overlaps existed, mainly in the programmatic areas, the Management and Human Performance Root Cause Report. In addition, Exponent and FENOC staff, including some members of the re-assembled team, met with several principal authors of the Exponent Report to provide an opportunity for them to provide an explanation of how they considered the operational observations.

Exponent used recent experimental data and Computational Fluid Dynamic modeling to provide information on the thermal-hydraulic conditions that contributed to the RPV head wastage. The Exponent Report does not fully explain all of the operational conditions observed in the years before discovery and the Technical Root Cause Report does not go into depth of the metallurgical phenomenon of the actual crack progression and wastage.

After further evaluating the information in the Exponent Report, including the input of Exponent during the process to respond to this DFI, FENOC continues to believe that the current Technical Root Cause Report and Management and Human Performance Root Cause Report provide a comprehensive explanation of the progression and causal factors of the Davis-Besse RPV head degradation event and, hence, contain the most appropriate information to have used in development and implementation of corrective actions to prevent recurrence. FENOC also concludes that if the BACC program had been implemented correctly, leakage from CRDM nozzles would have been detected prior to 12RFO.

An Expert Panel, convened by NEI, reviewed the Exponent Report to determine if it called into question the adequacy of the industry's operational monitoring or inspection program. The Expert Panel determined that reported crack growth rates are within the industry data for primary water stress corrosion cracking and that the wastage mechanisms and rates are within the bounds previously described by the Electric Power Research Institute. Therefore, the operational monitoring and inspection programs that have been taken remain effective for both Davis-Besse and the rest of the nuclear power industry, and current industry inspection requirements would have detected the nozzle cracking prior to 12RFO.

FENOC supports the continued validity of the results of our root cause analyses associated with the RPV head degradation event. In the extensive comparison of the assumptions, analysis, conclusions, and other related information appearing in the Exponent Report against the docketed FENOC root cause reports, FENOC continues to believe that visible indications of nozzle leakage and head degradation were present prior to 12RFO in 2000, and that proper implementation of our BACC program, including proper cleaning of the RPV head, would have resulted in finding the leaks.

Demand C:

With regard to the "Report on Reactor Pressure Vessel Wastage at the Davis-Besse Nuclear Power Plant," dated December 2006, indicate if FENOC endorses the report's conclusions. If so, your response shall set forth your assessment of whether this position is in conflict with previous root cause and licensee event reports regarding the 2002 Davis-Besse reactor pressure vessel head degradation event and FENOC's responses to the NRC Notice of Violation and Proposed Imposition of Civil Penalties, dated April 21, 2005. Your response shall also address the impact on the continued effectiveness of your corrective actions.

I. Introduction

Like the Exponent Report, Dr. Mattson's report entitled "Report on Reactor Pressure Vessel Wastage at the Davis-Besse Nuclear Power Plant" (Mattson Report) was prepared for the arbitration in support of FENOC's insurance claim. It is not a licensing document, nor does it contain a technical analysis of the type found in the Exponent Report. A fundamental purpose of the Mattson Report is to discuss NEIL's argument that the damage to the reactor was caused in some way by deliberate violations of the Davis-Besse BACC program. Dr. Mattson's professional opinions are not of a type that can be readily verified or tested in an objective way. Rather, they reflect his personal views based upon his education, experience as a regulator and as a nuclear industry consultant, and his research as part of the report preparation.

Therefore, in light of the nature of Dr. Mattson's opinions, FENOC is, in some cases, not in a position to specifically endorse or disagree with the conclusions because they are the professional opinion of Dr. Mattson. In those cases, FENOC believes it is Dr. Mattson's obligation to defend his opinions before the arbitration panel.

FENOC's assessment of the conclusions in Section 9 of the Mattson Report is provided below. If FENOC endorses a conclusion, in whole or in part, then it provides an assessment of whether it conflicts with the root cause reports, the LER, or FENOC's responses to the Notice of Violation and Proposed Imposition of Civil Penalties (NOV) dated April 21, 2005. Finally, FENOC addresses the continued effectiveness of its corrective actions.

II. Evaluation of Conclusions

1. **"NRC sets and interprets the rules governing the safety of nuclear power plants in the United States. Although the licensees are primarily responsible for safety, NRC and the licensees share the responsibility for ensuring that nuclear reactors are operated safely. The nuclear industry is very closely regulated. The NRC knows what is going on in the plants it regulates."**

Response: FENOC endorses this conclusion in that the NRC sets and interprets its rules governing the safety of nuclear power and closely regulates the nuclear industry. FENOC recognizes that it has the responsibility under its licenses to safely operate its fleet of plants and that NRC has the separate responsibility to oversee licensee performance to independently provide reasonable assurance that licensee activities are conducted in a manner to assure the public health and safety. To this end, NRC pervasively regulates and generally knows what is going on in the plants it regulates, but does not have knowledge of plant activities to the same extent as the licensee. FENOC's position is not in conflict with FENOC's root cause, the LER regarding the event, or FENOC's responses to the Notice of Violation and Proposed Imposition of Civil Penalties, issued by the NRC on April 21, 2005. This endorsement does not change the continued effectiveness of our corrective actions.

2. **"The NRC relies on hindsight in gleaning lessons from operating experience so as to prevent very low probability events in the future. It uses hindsight in its reports or those provided by its licensees that describe retrospective analyses of operating events, such as root cause assessments."**

Response: FENOC endorses the conclusion that the NRC relies, in part, on hindsight in gleaning lessons from operating experience so as to prevent low probability events. FENOC believes that the Reactor Oversight Process (ROP) is a robust regulatory process. The ROP is anchored in the NRC's mission to ensure public health and safety in the operation of commercial nuclear power plants. Although the ROP does not solely rely on hindsight for regulation, hindsight is appropriately a part of the regulatory process. FENOC's position is not in conflict with FENOC's root cause, the LER regarding the event, or FENOC's responses to the Notice of Violation and Proposed Imposition of Civil Penalties, issued by the NRC on April 21, 2005. This endorsement does not change the continued effectiveness of our corrective actions.

3. **"Hindsight is [in]appropriate to use in judging the reasonableness of performance because what could have been done, with foreknowledge of the outcome, is not a reasonable standard of performance."**

Response: FENOC is not in a position to either endorse or disagree with this conclusion. However, as stated in the response to conclusion 2, the ROP does not solely rely on hindsight for regulation; hindsight is appropriately a part of the regulatory process.

4. **"Davis-Besse was a superior performing plant in the years leading up to the discovery of wastage in the reactor vessel head."**

Response: FENOC does not endorse this conclusion. FENOC understands that Dr. Mattson relies upon NRC findings and violations and NRC Performance Indicators as evidence in support of his conclusion. Regardless of the perception that these statistics give relative to the performance of Davis-Besse in the years leading up to the discovery of the wastage in the reactor vessel head, FENOC has accepted, consistent with its several root cause reports, that the failure to properly implement the BACC program was not consistent with the performance of a superior performing plant in the years leading up to the discovery of wastage in the reactor pressure vessel.

5. **"The NRC licensing staff approved and its inspectors were aware of the implementation of the boric acid control program at Davis-Besse, as evidenced by inspection records before the RPV head wastage was found and by testimony to investigators after the fact."**

Response: FENOC does not endorse the conclusion that the NRC licensing staff approved FENOC's boric acid control program. The record cited by Dr. Mattson reflects the extent to which NRC was aware of the content and implementation of FENOC's program. Regardless of the level of knowledge of the NRC licensing staff and inspectors, FENOC is solely responsible for the proper implementation of the boric acid corrosion control program.

6. **"Implementation of the boric acid corrosion control program at Davis-Besse was similar to the implementation of such programs at other plants as evidenced by NRC inspection records before and after RPV wastage was discovered at Davis-Besse and by generic issuances of the NRC after the event."**

Response: FENOC is not in a position to endorse or disagree with this conclusion. Regardless of FENOC's performance relative to implementation of boric acid corrosion control programs at other plants, FENOC acknowledges it was and remains solely responsible for the proper implementation of the boric acid corrosion control program at Davis-Besse. Consistent with the root cause conclusions, FENOC failed to properly implement its boric acid corrosion control program.

7. **"A number of NRC personnel at the plant, in the region and at headquarters and some FENOC contractors, including Framatome support personnel, received the same early indications of corrosion products in containment (boric acid accumulation on the RPV head, in containment and on air coolers; iron in the radiation filters; etc.) that FENOC had and made similar conclusions about their lack of significance, thus confirming the reasonableness of FENOC's conclusions."**

Response: FENOC is not in a position to endorse or disagree with this conclusion. Regardless of the level of knowledge of the NRC personnel and FENOC contractors, FENOC acknowledges it was and remains solely responsible for the proper implementation of the boric acid corrosion control and corrective action programs. Consistent with the root cause, the cited early indicators were missed opportunities to detect the ongoing leakage of the head for a prolonged period.

8. **"The Violations and Civil Penalty issued by NRC for the RPV wastage were not for willful violation of the BACC program. My review also found no indication of willful violation of the BACC."**

Response: FENOC understands Dr. Mattson's point in that the language of the Notice of Violation, as distinct from the NRC cover letter, does not set forth specific factual information establishing willfulness. The NRC Notice of Violation cover letter, dated April 21, 2005, states the cited violations "...clearly documented a pattern of willful violations of FENOC's boric acid corrosion control and corrective action programs over a protracted period of time..."

FENOC's position is unchanged since the responses to the Notice of Violation and Proposed Imposition of Civil Penalties, issued by the NRC on April 21, 2005, the Acknowledgements and Admissions set forth in the Deferred Prosecution Agreement, the findings of the root cause reports, and the LER regarding the RPV head degradation event. FENOC admits that it violated its BACC program in the manner set forth in NRC's April 21, 2005, NOV, and as a result failed to remove all of the boric acid deposits found on the Davis-Besse RPV Head during 12 RFO, and failed to inspect the bare metal surface of the entire RPV Head during 12 RFO. As to willfulness, as stated in its September 14, 2005, response to the NOV, "We specifically are not addressing the allegation of willfulness contained in the April 21, 2005 transmittal letter because the NOV itself does not cite willfulness and a specific response to those allegations is not required."

In January 2006, FENOC also admitted that the Department of Justice can prove that from September 3, 2001, through November 28, 2001, FENOC employees, acting on its behalf, knowingly made false representations to the NRC in the course of attempting to persuade the NRC that Davis-Besse was safe to operate beyond December 31, 2001. Later, on January 23, 2006, FENOC supplemented its earlier response to the NRC's NOV to incorporate this admission, but it did not change FENOC's position on our violation of the BACC program.

9. **"Like other Civil Penalties issued by NRC, the size of the penalty issued to FENOC was meant in part to send a message to the rest of the industry."**

Response: FENOC is not in the position to either endorse or disagree with this conclusion. The Notice of Violation and Imposition of Civil Penalties, dated April 21, 2005, delineates the reasons for the amount of the Civil Penalties.

10. **"The RPV wastage at Davis-Besse could not have reasonably been predicted because of the state of knowledge at the time about boric acid corrosion throughout the industry and at Davis-Besse. The following are examples of misconceptions that have been eliminated with the benefit of hindsight applied to the Davis-Besse event:"**

- **"Reactor pressure vessel failures are incredible because of assurances provided based on an approach developed nearly 4 decades ago;"**
- **"If boric acid is dry and at high temperature there will be no corrosion (this ignores intermediate states of boric acid);"**
- **"The relatively high temperature of the Davis-Besse RPV head inhibited corrosion;"**
- **"The peripheral nozzles in the RPV head are more vulnerable to cracking than the central nozzles because of higher stresses on the periphery;"**
- **"The most serious consequence of longitudinal cracks in CRD nozzles is that they lead to circumferential cracks;"**

- **"Rod ejection and loss of coolant accidents are the most serious things that can happen with CRD nozzle cracking:"**
- **"Longitudinal nozzle cracks are not as dangerous because they leak before they break and are readily observable on walk downs;"**
- **"One gallon per minute of unidentified leakage from a nuclear reactor is acceptable;"**
- **"Old boric acid deposits are brown (dark);"**
- **"Boric acid deposits on the reactor head inhibit corrosion of the head by preventing exposure to oxygen;"**
- **"Boric acid deposits are usually flaky; and"**
- **"Leaking nozzles only cause popcorn-like boric acid deposits."**

Response: The Exponent Report and the Technical Root Cause Report found that "significant damage" to the reactor head was "unexpected." In NRC Bulletin 2001-01, the NRC recounts the discoveries of cracked and leaking Alloy 600 Vessel Head Penetration (VHP) Nozzles, including CRDM and thermocouple nozzles at Oconee and Arkansas Nuclear One (ANO). In 1996, in a Davis-Besse Potential Condition Adverse to Quality Report, it was noted that boron deposits around the CRDM nozzles and on the RPV head could cause corrosion of the head. Given this knowledge, and the discovery of cracked and leaking VHP nozzles at Oconee and ANO, FENOC believes we should have discovered the nozzle leakage and some corrosion to the RPV head prior to RFO12 in 2000. As a result, we should have cleaned and inspected the metal surface of the RPV head in accordance with the BACC program. Therefore, FENOC does not fully endorse this conclusion.

11. **"As a result of these misconceptions, NRC, FENOC and the entire nuclear industry shared a cognitive dissonance (mindset) on the improbability of significant vessel head wastage by boric acid."**

Response: FENOC is not in a position to endorse or disagree with this conclusion. Regardless of the level of knowledge of the NRC and the rest of the industry, and its own misconceptions, FENOC acknowledges it was and is solely responsible for the proper implementation of the boric acid corrosion control and corrective action programs.

12. **"There were alternative interpretations of the indications of the onset of RPV wastage:"**

- **"Other sources of iron on radiation filters were plausible."**
- **"SWRI said the iron on the filters came from a high location in containment."**
- **"There had been chronic leakage from the CRD flanges above the insulation on the RPV head."**
- **"Other sources of leakage (e.g., CRD flanges) had caused contamination of containment air coolers in the past."**
- **"Leaking control rod drive flanges produced lots of boron deposits, while cracked control rod drive nozzles were understood to lead to very small deposits of boron."**
- **"Special inspections by FENOC to locate unidentified reactor leakage found other sources that appeared to account for nearly all the leakage."**
- **"As events unfolded in real time, the possibility that the corrosion products seen in containment were associated with unidentified RCS leakage and possible RPV head wastage did not occur to anyone, not FENOC and its contractors, including Framatome, not NEIL, not the CNRB, and not the NRC."**
- **"This is the first time significant material wastage has ever been reported below the top of the RPV head. There were no precedents for its occurrence. Framatome's risk assessment concluded this type of failure would take a long time to occur and would be detected before it progressed significantly."**

<u>Response</u>: While FENOC agrees that some alternative interpretations of the indications existed at the onset of RPV wastage, FENOC does not endorse this conclusion. FENOC failed to properly assess, in aggregate, the meaning of the available evidence. Regardless of the presence of alternative interpretations, lapses in the Boric Acid Corrosion Control Program and Corrective Action Program contributed to reactor coolant system pressure boundary leakage going undetected for a prolonged period.

13. **"Boron deposits on the vessel head did not damage the head. Rather, RPV head wastage occurred in the annulus between the Alloy 600 CRD nozzle and the carbon steel RPV head, below the top of the head. The cause of the wastage was through-wall leakage via longitudinal cracks in the CRD nozzles, which industry and NRC considered in the past and dismissed as being observable before damage occurred."**

Response: FENOC does not endorse this conclusion. While the root cause reports acknowledge that the overall event resulted from CRDM nozzle leakage associated with through-wall cracking, FENOC does not agree that the boron deposits on the vessel head had no effect in damaging the head. The deposits that were not removed from the vessel head as a result of the failure to comply with the requirements of the BACC program prevented the detection of the leaks. Additionally, it is uncertain how the supply of boric acid on the head interacted in the annulus and evolving cavity associated with the nozzle leakage. Besides the cavities discovered at Nozzle 2 and Nozzle 3, there was some wastage of the general surface of the head in the quadrant around and below these nozzles, which was covered with boric acid. Furthermore, the leakage from cracked nozzles was expected to be observable because the regulatory guidance reflected in the BACC program required the cleaning of the head and a full head inspection, which was not occurring at Davis-Besse.

14. **"Since the Davis-Besse event, the NRC is saying that bare metal visual observation is not sufficient to find nozzle cracks. Licensees are required to use ultrasonic testing or other approaches that require access through the bottom of the vessel head while it is removed during refuelings. This new NRC approach tends to confirm that the wastage at Davis-Besse probably was not discernable even if the RPV head had been completely cleaned of boric acid residue at the end of RFO12."**

Response: FENOC does not endorse this conclusion. FENOC had the responsibility to inspect for nozzle leakage on the Davis-Besse head. The root cause report concludes that had Davis-Besse been performing these bare head visual inspections in accordance with the regulatory expectations of that era, the CRDM nozzle leakage would have been identified prior to 12RFO.

15. "The recriminations of individuals and organizations at Davis-Besse after the event have to be taken with cognizance of hindsight, as do those of the NRC. Organizations so challenged will always find missed opportunities to have done better because of the psychological phenomenon called hindsight bias."

Response: FENOC is not in a position to endorse this conclusion. FENOC has not independently performed an evaluation of the phenomenon of "hindsight bias."

III. Summary

As demonstrated above, FENOC completed an assessment of the conclusions in Section 9 of the Mattson Report. Although we agree with some statements and conclusions, FENOC does not endorse the document in its entirety. Although not endorsing the report in its entirety, FENOC does agree that it did not deliberately damage the RPV head by our violation of the BACC program. The conclusions FENOC does endorse are not in conflict with the root cause reports and the LER regarding the RPV head degradation event, nor FENOC's responses to the Notice of Violation and Proposed Imposition of Civil Penalties, issued by the NRC on April 21, 2005. Further, our corrective actions remain effective considering the positions taken in this response to Demand C.

Attachment 2
Commitment List

The following table identifies those actions committed to by FENOC. Any other statements in this letter are provided for information purposes and are not considered regulatory commitments. Please notify Mr. Gregory H. Halnon, Director, Fleet Regulatory Affairs, at (330) 384-5638, of any questions regarding this document or associated regulatory commitments.

Commitment	Due Date
FENOC will develop a formal process to review technical reports prepared as a part of a commercial matter. The process will provide criteria for FENOC to utilize to determine if the report has the potential for regulatory implications or impact on nuclear safety both at our sites and within the nuclear industry. This process will provide for the timely and critical evaluation of this type of report and will complement our existing formal nuclear process for obtaining technical reports from our agents and contractors.	12/14/2007
FENOC will also provide an OE document to the nuclear industry through the established OE process. This OE document will discuss the issues surrounding this DFI, including the review of technical reports prepared as part of a commercial matter.	8/10/2007
Process changes will be made to the NRC Correspondence procedure to ensure specific questions are asked during the process relative to the experience gained from the efforts to respond to this DFI.	12/14/2007
FENOC's policy on Regulatory Communications will be assessed for potential enhancements through CAP.	11/30/2007
The May 2, 2007 response to the April 2, 2007 NRC Request for Information was narrow in scope and resulted in unintended conclusions relative to FENOC's regulatory position. This will be addressed through the Corrective Action Program.	11/30/2007