FENOC
FirstEnergy Nuclear Operating Company

Davis-Besse Nuclear Power Station

INTEGRATED REPORT TO SUPPORT RESTART OF THE DAVIS-BESSE NUCLEAR POWER STATION

Approvals:

Mark B. Bezilla Site Vice President	Date
Lew W. Myers Chief Operating Officer	Date
Gary R. Leidich President and Chief Nuclear Officer	Date

Safety ✧ *People* ✧ *Reliability*

FirstEnergy Nuclear Operating Company

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Acronyms

ANSI	American National Standards Institute
AOV	Air Operated Valve
ASME	American Society of Mechanical Engineers
BACC	Boric Acid Corrosion Control
BPC	Boron Precipitation Control
CA	Corrective Action
CAC	Containment Air Cooler
CAL	Confirmatory Action Letter
CAP	Corrective Action Program
CARB	Corrective Action Review Board
CCW	Component Cooling Water
CDF	Core Damage Frequency
CNO	Chief Nuclear Officer
CNRB	Company Nuclear Review Board
COO	Chief Operating Officer
CR	Condition Report
CRDM	Control Rod Drive Mechanism
Davis-Besse	Davis-Besse Nuclear Power Station
DBA	Design Basis Accident
DBVP	Design Basis Validation Program
DH/LPI	Decay Heat/Low Pressure Injection
DHR	Decay Heat Removal
EAB	Engineering Assessment Board
ECCS	Emergency Core Cooling System
ECP	Employee Concerns Program
EDG	Emergency Diesel Generator

Acronyms

EDS	Electrical Distribution System
ELMS	Electrical Load Management System
EOC	Extent of Condition
EPRI	Electric Power Research Institute
EQ	Environmental Qualification
ETAP	Electrical Transient Analysis Program
EWR	Engineering Work Request
FENOC	FirstEnergy Nuclear Operating Company
HELB	High Energy Line Break
HIRD	Harassment, Intimidation, Retaliation, and Discrimination
HPES	Human Performance Evaluation System
HPI	High Pressure Injection
HVAC	Heating, Ventilation, and Air-Conditioning
IAEA	International Atomic Energy Agency
ILRT	Integrated Leak Rate Test
IMC	Inspection Manual Chapter
IMI	In-Core Monitoring Instrumentation
INPO	Institute of Nuclear Power Operations
ISI	Inservice Inspection
LER	Licensee Event Report
LERF	Large Early Release Frequency
LIR	Latent Issues Reviews
LOCA	Loss-of-Coolant Accident
MRB	Management Review Board
MS	Main Steam
NCOB	Nuclear Committee of the Board

Acronyms

NDE	Non-Destructive Examination
NOP	Normal Operating Pressure or Nuclear Operating Procedure
NQA	Nuclear Quality Assessment
NRC	U.S. Nuclear Regulatory Commission
PCSP	Permanent Cavity Seal Plate
PM	Preventive Maintenance
PRC	Project Review Committee
PSA	Probabilistic Safety Assessment
PSHA	Performance, Safety and Health Associates
PWSCC	Primary Water Stress Corrosion Cracking
QA	Quality Assessment
QC	Quality Control
RCP	Reactor Coolant Pump
RCPB	Reactor Coolant Pressure Boundary
RCS	Reactor Coolant System
RFO	Refueling Outage
ROP	Restart Overview Panel
RP	Radiation Protection
RPV	Reactor Pressure Vessel
RSMT	Restart Senior Management Team
RSRB	Restart Station Review Board
SCAQ	Significant Condition Adverse to Quality
SCWE	Safety Conscious Work Environment
SFAS	Safety Features Actuation System
SFRCS	Steam and Feedwater Rupture Control System
SFVP	Safety Function Validation Project

Acronyms

SG	Steam Generator
SLT	Senior Leadership Team
SMT	Senior Management Team
SRO	Senior Reactor Operator
SSCs	Systems, Structures and Components
SW	Service Water
USAR	Updated Safety Analysis Report

Executive Summary

A. Purpose

FirstEnergy Nuclear Operating Company (FENOC) has determined that the Davis-Besse Nuclear Power Station (Davis-Besse) has completed the actions necessary to ensure safe and reliable return to service and, subject to completion of the remaining scheduled activities, is ready to restart. This Report documents the basis for this determination.

B. Description and Event Chronology

On March 6, 2002, Davis-Besse identified a cavity in the reactor pressure vessel (RPV) head. In response, the U.S. Nuclear Regulatory Commission (NRC) issued a Confirmatory Action Letter (CAL) and established an Inspection Manual Chapter (IMC) 0350 Oversight Panel, which developed a restart checklist identifying those issues requiring resolution before restart. In response to the event and the CAL, Davis-Besse performed various root cause analyses and assessments and developed a Return to Service Plan with seven Building Blocks. These include actions to address the commitments in the CAL, the near-term corrective and preventive actions to address the causal factors associated with the RPV head degradation, and the longer-term actions necessary to assure that the underlying causal factors remain corrected and that continued safe performance at Davis-Besse is maintained. Each of these is summarized below.

C. Root Cause Analyses and Assessments

Numerous root cause analyses and assessments have been performed, including evaluations of the root causes of the RPV head degradation; assessments of Nuclear Quality Assessment (NQA), Operations, corporate management, the Corrective Action Program (CAP), the Company Nuclear Review Board (CNRB), and Engineering; and a collective significance review. As a result, it was determined that:

- The RPV head degradation resulted from primary water stress corrosion cracking (PWSCC) in control rod drive mechanism (CRDM) nozzles, which led to a through-wall leak of boric acid and boric acid corrosion of the RPV head.

- A production focus established by management, combined with taking minimum actions to meet regulatory requirements, resulted in acceptance of degraded conditions on the RPV head and other components affected by boric acid.

- There were deficiencies with respect to: (1) the implementation of the CAP; (2) the analyses of safety implications of industry information and site experience; (3) compliance with the Boric Acid Corrosion Control (BACC) and Inservice Inspection (ISI) programs; (4) NQA oversight; (5) Operations' leadership role in assuring plant safety; and (6) the safety focus of the CNRB.

In summary, both the technical and organizational causes of the head degradation have been identified. As discussed below, corrective and preventive actions have been taken to address these causes.

D. Return to Service Plan and Building Block Plans

1. Reactor Head Resolution Plan

The degraded Davis-Besse RPV head was replaced with a new one from the canceled Midland Plant. The Midland RPV head was certified in accordance with the American Society of Mechanical Engineers (ASME) Code. The procurement contractor for the new RPV head provided the required documentation, supplemental non-destructive examinations, analyses, and ASME Code reconciliation necessary to ensure the original ASME documentation remains valid, and that the replacement RPV head complies with appropriate NRC and industry requirements.

To accommodate removal of the original RPV head and installation of the replacement, access openings were installed in both the shield building and containment vessel. Following installation of the new RPV head, the containment was returned to its original design configurations, and a successful containment integrated leak rate test (ILRT) was conducted.

After installation of the new RPV head, the reactor coolant system (RCS) was brought to normal operating pressure (NOP). Visual inspections were performed for evidence of leakage. The RPV head-to-flange seals and the control rod drive mechanisms were confirmed to be leak tight. In addition, zero pressure boundary leakage was confirmed.

In summary, the replacement RPV head is in compliance with applicable NRC and industry requirements and is ready to support safe power operation.

2. Containment Health Assurance Plan

Inspections of systems, structures, and components (SSCs) within containment were performed to ensure that their condition supports safe operation. The plan focused on the extent of condition of PWSCC in the RCS and identifying damage that may have resulted from boric acid leakage and dispersion of boric acid in the containment.

As a result of its inspections, over 950 condition reports (CRs) were generated. It was determined that the containment air coolers (CACs) were significantly impacted by boric acid, and the coolers were rebuilt. Degradation of other components was identified and, as appropriate, these components were replaced or repaired. It was determined that the boric acid deposition did not impact the environmental qualification (EQ) of any equipment. Additionally, inspections, analyses and tests were performed to provide reasonable assurance that penetrations at the bottom of the RPV are not leaking.

In conclusion, comprehensive inspections have been conducted of SSCs within containment, and appropriate corrective actions have been taken. As a result, Davis-Besse concludes that the condition of the SSCs within containment supports safe restart and operation after containment closure by the Operations section.

3. Program Compliance Plan

The Program Compliance Plan consisted of a two-phase review of applicable plant programs. Phase 1 was a baseline assessment of approximately 65 plant programs to determine if the programs are in a condition to support the restart and safe operation of Davis-Besse. Phase 2 was an in-depth systematic review of several programs.

As a result of the Phase 1 reviews, deficiencies were identified and evaluated. The restart-related deficiencies have been or are being corrected, and the responsible managers have affirmed the readiness of their programs to support return to service and safe operation. In response to the Phase 2 reviews, the following improvements have been made:

- Corrective Action Program – Davis-Besse implemented several actions to improve operability evaluations, categorization of CRs, cause determinations, effectiveness of corrective actions, and timeliness of corrective actions.

- Operating Experience Program – Davis-Besse implemented a new screening and evaluation process, expanded the operating experience information dissemination methods, formalized the internal/FENOC operating experience process, and documented the expectations for the use of operating experience.

- Quality Audits – The Quality Assessment Manager at each station now reports to the Vice-President of Oversight, who in turn reports to the President of FENOC and the Nuclear Committee of the Board of Directors. The CNRB procedure now requires the CNRB to place emphasis on nuclear safety. Quality Control Inspectors have been moved into the NQA group.

- Self-Assessments – A business practice was created to provide guidance for developing, maintaining, and assessing plant programs. Corporate program managers have been established to oversee specific programs and to facilitate the use of the best industry practices as the standard practice at FENOC's plants.

- BACC Program – Davis-Besse revised the BACC Program Manual to include the CRDM nozzles as a probable location of leakage, hired a new plant BACC Program Owner, and implemented a new Job Familiarization Guideline for boric acid inspectors and the BACC Program owner.

- RCS Integrated Leakage Program – Davis-Besse developed and implemented an RCS Integrated Leakage Program to improve the capability for detecting and correcting small leaks that are within the limits of the Technical Specifications.

- ISI Program – Davis-Besse revised the ISI program to provide for the performance of augmented examinations for selected components, including the CRDM nozzles. Additionally, a formal interface between the ISI Pressure Test and the BACC Program has been established, and training of personnel has been revised to emphasize identification of the leakage source.

- Modifications Program – Davis-Besse developed and implemented a common procedure modeled after industry best practices. A more formal design input process has been established to identify and document pertinent design information at the beginning of the design development, and strengthen the design interface process.

- Radiation Protection (RP) – Davis-Besse hired a new FENOC RP Program Manager (who is currently serving as acting site RP Manager), several additional professional staff, and established improved RP standards and expectations. Additionally, state-of-the-art instrumentation and equipment have been purchased and placed into service.

In total, over 600 restart corrective actions for programs have been completed. Based upon its reviews and corrective actions, Davis-Besse concludes that its programs are ready to support safe and reliable operation.

4. System Health Assurance Plan

The initial scope of the System Health Assurance Plan included: (1) Operational Readiness Reviews to identify whether systems have significant shortcomings; (2) In-depth System Health Readiness Reviews to provide reasonable assurance that systems can perform their risk-significant maintenance rule functions; and (3) Latent Issues Reviews (LIRs) of five systems to provide reasonable assurance that these systems can perform their safety and accident mitigation functions. The system design reviews identified numerous discrepancies, including a number of conditions with potential safety significance (mostly due to calculation problems). Discrepancies were evaluated for the potential effect on operability. For conditions affecting operability, corrective actions have been or are being taken to restore the system, and an evaluation was performed to determine the extent of condition (EOC).

A Safety Function Validation Project (SFVP) was established to provide additional assurance that systems are capable of performing their safety functions. These reviews consisted of an evaluation of the calculations and testing for 15 systems with risk-significant safety functions. Based upon SFVP, it was determined that, with several exceptions, the 15 systems could perform their safety functions. As a result, appropriate corrective actions are being taken to restore the systems and components in question to operability before restart, and evaluations have been performed to bound the EOC.

Additionally, a collective significance review of identified conditions was performed to determine which topical areas warranted further evaluation. Five of these areas had not been the subject of previous reviews: high-energy line break (HELB), EQ, seismic, Appendix R - safe shutdown, and flooding. Therefore, topical area reviews of these areas were performed to bound their extent of condition.

As a result of these reviews and actions, Davis-Besse concludes that there is reasonable assurance that plant systems can perform their design-basis safety functions and are ready to support safe restart and operation of Davis-Besse.

5. Management and Human Performance Excellence Plan

The purpose of the Management and Human Performance Excellence Plan was to conduct a thorough assessment of the management and organizational issues surrounding the degradation of the RPV head and create a comprehensive leadership and organizational development plan for the site. Based upon the assessments, actions have been taken to improve management and human performance, as summarized in Section E below.

The Plan also included a functional area review of the operational readiness of Plant Operations, Chemistry/Radiation Protection, Maintenance and Work Management. Based upon these reviews, Davis-Besse has identified and implemented a number of actions to improve its organizations, and concludes that the organizations are ready for restart.

6. Restart Test Plan

Testing was performed to ensure the integrity of the RCS and the containment pressure vessel, systems and components affected by RCS leakage and boric acid deposits (*e.g.*, CACs and associated duct work were evaluated). In addition, an integrated restart process is in place to ensure that proper sequencing of required restart activities is accomplished prior to mode ascension.

7. Modifications, Program Improvements, and Management Actions to Improve Safety Margins

A number of actions to improve safety margins have been implemented, including modifications to many SSCs, improvements to various plant programs, and changes to FENOC and Davis-Besse management. For example, these actions include the following:

- Expansion of the emergency containment sump screen surface area by a factor of approximately 20. This modification has placed Davis-Besse in the forefront of all pressurized water reactors (PWRs) in the United States in addressing generic issues related to containment sumps.

- Installing a permanent steel plate liner within the decay heat valve tank to improve protection against seepage of water into the tank during an accident.

- Replacing the casing-to-cover gaskets, rotating elements, and motors on two of the reactor coolant pumps (RCPs); rebuilding and replacing the mechanical seals on all four RCPs; and installing new diagnostic equipment for the RCPs.

- Installing a state-of-the art system (and first of a kind in the United States) leak detection system, FLÜS, on the lower RPV head.

- Reducing the potential for generation of debris during an accident by upgrading coatings and minimizing the amount of fibrous insulation in containment.

Changes have been made in numerous plant programs, including the CAP and RCS Integrated Leakage Program. The CAP was extensively reviewed and significantly improved. For example, the CARB has been strengthened and is chaired by a Director level position. In addition, the categorization of CRs has also been strengthened.

The RCS Integrated Leakage Program is currently being revised to incorporate lessons learned during the sensitivity test and to incorporate a new algorithm into the existing RCS Water Inventory Balance Test. Once incorporated, the program will be able to identify small changes in the amount of unidentified leakage and trend this information.

With regard to management changes, a number of new management positions have been added to the FENOC corporate organization. These include the Chief Operating Officer, Senior Vice President – Engineering and Services, Vice President – Oversight, and a corporate staff of program owners and equipment experts under the leadership of the Director – Nuclear Services. These new management positions will facilitate the consistent implementation of programs at all three nuclear plants. A new management team has also been installed at Davis-Besse. The new managers have proven records, extensive nuclear experience, and many have or had senior reactor operator (SRO) licenses or certifications. In addition, Davis-Besse managers are now graded against the new leadership principles.

8. Reviews of Extent of Condition of 10 CFR § 50.9 Issues

In an inspection report issued in October 2002, the NRC identified two documents provided to the NRC by Davis-Besse that contained information that was not complete and accurate in all material respects. In addition, this inspection identified quality records required by 10 CFR Part 50, Appendix B, which contained inaccurate or incomplete information. To help ensure the completeness and accuracy of future records and submittals to NRC, Davis-Besse issued a new policy stressing the need for complete and accurate information, provided training to personnel on the need for complete and accurate information, and issued a new procedure governing validation, review, and approval of correspondence to the NRC.

The completeness and accuracy of a sample of prior submittals to the NRC was reviewed. The review encompassed over 2,200 statements of fact and found only about 0.2% to contain material inaccuracies or omissions. Furthermore, none was found to have significant implications for public health and safety or common defense and security. These results indicate that there were no widespread noncompliances or programmatic concerns associated with Davis-Besse's correspondence to NRC.

9. Conclusions

In summary, Davis-Besse established comprehensive Building Block Plans to replace the degraded RPV head, to determine whether other SSCs may have been adversely affected by PWSCC or boric acid corrosion, to verify that SSCs can perform their design basis functions, and to ensure the adequacy of plant organizations and programs. Based upon these Plans, numerous corrective actions have been performed. Davis-Besse concludes that the organizations, programs, and SSCs will be ready to support safe and reliable operation.

E. Management and Human Performance Improvements

1. Improvements in Management/Personnel Development

FENOC has appointed a new President and has created three executive positions, including a Vice President of Oversight. Additionally, the top two levels of management at Davis-Besse have been entirely replaced, and almost all of the third level has been replaced. The new management team is largely drawn from outside of Davis-Besse, including several proven performers from outside of the Company. The Senior Leadership and Management Teams have over 400 years of nuclear experience and all key managers have or have held senior operator licenses or certificates. See Figures 4 and 5 on pages 75 - 77.

A number of actions have been taken to strengthen management actions. For example, a common set of standards has been put in place for management personnel and new accountabilities have been set for directors and managers in the areas of Nuclear Professionalism and Nuclear Safety Consciousness. Evaluations have been performed of executives, directors, managers, and selected supervisors to verify their competence for their current positions, including the adequacy of their nuclear safety focus. Leadership training has been implemented for the management team to anchor the new standards. Additionally, a Management Observation Program was implemented, which requires management personnel to observe plant activities and provide feedback to personnel.

Various performance indicators and assessments at Davis-Besse show improved performance, reflecting upon effectiveness of the new management team. The actions of the new FENOC and Davis-Besse management team also demonstrate that they have high safety standards and are involved in directing and overseeing plant activities. Therefore, FENOC concludes that its management is ready for restart and safe operation.

2. <u>Improvements in Safety Culture</u>

The FirstEnergy Board of Directors has issued a resolution to communicate from the highest level the significance of nuclear safety. Additionally, the Chief Executive Officer of FirstEnergy has met with Davis-Besse personnel to express his policy that safe nuclear operations require an unrelenting and uncompromising commitment to safety.

Multiple forums have been employed to communicate high standards and obtain feedback from personnel, including town hall meetings, meetings between the Chief Operating Officer (COO) and small groups of employees, and Davis-Besse team meetings.

Case Study training was given to site personnel to ensure that they understand how the RPV head degradation event happened, what barriers broke down, and what needs to be different in the future. Additionally, employees were trained using Root Learning Tools to ensure personnel focus on safety.

FENOC has issued a policy statement on Safety Conscious Work Environment (SCWE) that emphasizes the importance of raising safety concerns and emphasizes that retaliation against individuals who raise concerns will not be tolerated. Managers and supervisors have received training on SCWE. A new Employee Concerns Program (ECP) has also been established. The ECP includes independent investigators and provisions for submitting anonymous concerns and maintaining the confidentiality of those concerns.

Davis-Besse and an independent contractor conducted assessments of safety culture in early 2003 and found several areas for improvement. In response, additional actions were taken to improve performance. In May 2003, a new department and position, Director of Organizational

Development, was created to focus on achievement of continuous improvement in safety culture and SCWE. In early September 2003, this position was changed to a FENOC corporate position to ensure alignment and improved safety culture throughout the nuclear organization.

These actions have been effective in improving the safety culture at Davis-Besse. For example, the Safety Culture Assessment performed for Mode 4b/2 showed substantial improvement relative to the results of the Mode 5 assessment, primarily due to completion of many actions needed for an improved safety culture, reduction of backlogs, and improvements in performance. As part of the Root Learning sessions conducted in the fall of 2003, a survey of site personnel was conducted to determine their perceptions of safety culture. On average, personnel agreed that Davis-Besse possesses the safety culture characteristics in three Commitment Areas (Policy Level, Management Level, and Individual Level) and personnel rated several safety culture characteristics between "agree to strongly agree," such as awareness of policies on safety culture, visible commitment to safety, and understanding of responsibility to raise safety or quality concerns. Similarly, the SCWE survey in November 2003 showed substantial improvement in almost every category compared to the survey in August 2002.

Additionally, the NOP test confirmed RCS boundary integrity and showed an unidentified RCS leak rate of essentially zero (*e.g.*, very low values for unidentified leakage), the best in the history of Davis-Besse. Furthermore, the number of concerns now being reported to the ECP far exceeds the number of allegations reported to NRC, demonstrating employee confidence in the ECP.

In summary, safety has the highest priority at Davis-Besse and takes precedence over other objectives, such as cost and production. Formal and informal surveys have demonstrated that site personnel feel free to raise safety concerns without fear of retaliation, and that concerns are investigated and resolved in a manner consistent with their safety significance. Therefore, Davis-Besse concludes that it is ready for restart in this area.

3. Improvements in Standards and Decision-Making

Improvements in this area have included establishing written technical expectations for the Davis-Besse staff; developing a Problem Solving and Decision Making Process; providing training to reinforce technical standards and problem solving skills; implementing an Operations leadership plan; and developing a checklist for pre-job briefings. Additionally, based on insights gained from the NOP Test, a change has been made to the pre-job briefings document to include reference to reverse briefings.

The results of several performance indicators show that Davis-Besse is producing better engineering products. It is recognized that there is room for improvement with respect to the quality of calculations and implementation of the problem-solving and decision-making procedure, and actions to achieve improvement in these areas have been implemented. Overall, decision-making and technical standards at Davis-Besse have a nuclear safety focus, have technical rigor, account for operating experience, and seek to correct problems rather than justifying acceptance of the problems. Therefore, Davis-Besse concludes that it is ready to restart in this area.

4. Improvements in Oversight and Assessments

An Engineering Assessment Board (EAB) has been established to review and reinforce higher and consistent standards for engineering and other selected technical documents. Additionally, a Management Observation Program has been established to improve management oversight, and actions have been taken to strengthen both NQA assessments and CNRB.

Performance indicators show that these actions have had a positive effect. For example, management has consistently met or exceeded its goal for management observations. Additionally, the results of the NQA assessments of the NOP test were similar to those of the external assessors, thereby demonstrating the effectiveness of NQA.

During the NOP test, assessments identified that management observations could be more self-critical, and actions have been taken to improve these observations. Additionally, NQA has recognized that its assessments are more effective when it uses outside personnel, and NQA plans to continue to use such personnel in its assessments.

Overall, there are adequate provisions for oversight, and assessments at Davis-Besse have been effective in identifying and obtaining correction of problems before they adversely affect safety. Opportunities for improvement have been identified and actions have been taken to achieve improved performance. Therefore, Davis-Besse concludes that it is ready for restart in this area.

5. Improvements in Corrective Actions and Procedure Compliance

As discussed in Section IV.D below, major changes have been made to the Corrective Action Program, including improvements in operability evaluations, categorization of conditions, cause evaluations, and the effectiveness of corrective actions. Performance indicators show that there have been improvements in corrective actions. For example, goals on categorization of CRs have been consistently met or exceeded (since early 2003), and the quality of the root cause analyses has shown an improving trend since August 2003 and meets the restart goals. Additionally, in the summer of 2003, NRC inspections and NQA assessments found that the root cause analyses were typically rigorous for significant conditions adverse to quality.

The assessments also identified weaknesses with respect to apparent cause analyses for conditions of lesser significance. In response, the number of Apparent Cause evaluators will be reduced and those personnel serving as evaluators will receive additional training. Additionally, the CARB is assessing the adequacy of apparent cause analyses until they meet Davis-Besse's goals. Given these actions and the effectiveness of its root cause analyses, Davis-Besse concludes that it is ready for restart in this area.

With respect to procedure compliance, standards and expectations and the need for work practice rigor have been reinforced. Licensed operators have been trained on their responsibilities for ensuring the safety and compliance with regulatory requirements and procedures. As mentioned above, a Management Observation Program was established to provide direct management observation of procedure compliance.

Performance indicator data, assessments and management observations show that personnel in general are complying with procedures. The assessments of the NOP test, however, showed some weaknesses with respect to procedure compliance, particularly in cases where the procedures lacked details. Actions are being taken to ensure that personnel obtain appropriate revisions to procedures in cases where they lack sufficient details. Therefore, Davis-Besse concludes that it is ready for restart in the area of procedure compliance.

6. Results of Assessments during NOP Tests and Follow-up Actions

Several assessments of performance during the NOP tests were conducted in September 2003. The findings included positive conclusions with respect to hardware quality and radiation protection. They also found that, when implemented properly, the processes and procedures used at Davis-Besse support safe and reliable plant operations. Furthermore, the assessments concluded that management demonstrated safe and effective operational decision making when challenged by emergent issues.

The assessments also identified areas for improvement with respect to the level of detail of the integrated operations procedures, the consistency of the implementation of the problem solving and decision-making procedure, the self-critical nature of management observations, Operator performance, maintenance of an oversight role and command and control by Operations management, and procedural compliance.

An Operations Improvement Action Plan has been developed to address these issues prior to restart. The Plan identifies actions to strengthen the operating crews, the integrated operating procedures, Operations management, and independent oversight of Operations prior to restart. For example, Operator knowledge and standards and expectations for command and control responsibilities of shift management will be evaluated and reaffirmed. An operational oversight team, consisting of external (industry personnel) and internal personnel, will function as operations oversight managers to provide additional oversight of plant operations during restart. Finally, training will be provided to site managers on performing management observations of operations. In total, these restart actions will establish additional barriers and improve operational performance to address the areas of weakness identified by the assessments during the NOP test.

7. Conclusions

Extensive actions have been taken to improve management and personnel development, safety culture, standards and decision-making, oversight and assessments, and corrective actions, programs, and procedure compliance. Various performance indicators and assessments demonstrate that these actions have been largely effective in achieving improved performance. Recent assessments have identified some areas of weakness and actions are being taken to address these weaknesses. As a result, Davis-Besse concludes that it is ready for restart in this area.

F. Long-Term Improvement Plans

In July 2003, FENOC established a new vision for its fleet of nuclear plants. The new vision is: "People with a strong safety focus delivering top fleet operating performance." To achieve this vision, the team identified five strategic objectives and a set of metrics to track success in achieving the objectives. These strategic objectives are:

- Safe Plant Operation;
- People Development and Effectiveness;
- Excellent Material Condition;
- Fleet Efficiency and Effectiveness; and
- Improved Outage Performance.

Consistent with these objectives, several long-term actions are being implemented. For example, a number of improvements have been made to the Management Observation Program, including evaluating the results of the observations to identify focus areas for increased management observations. Additionally, the work management process will be revised to determine the appropriate level of management oversight based on safety and potential consequences of the work.

The Senior Leadership Team (SLT) is holding meetings to gain consensus on its role in leading the culture change effort, develop check points to monitor progress, and determine the infrastructures needed to drive new behavior. FENOC is also holding a series of meetings with managers, supervisors, and employees to share the outcomes of these meetings, discuss FENOC's new vision, and engage personnel in safety culture change.

Using the FirstEnergy template, management and succession planning will be improved. FENOC will develop an overall, integrated process of recruiting talent, identifying talent, proactively identifying needs and planning to fill vacancies as they become open. Additional case study training was provided to station personnel on the meaning and importance of safety culture, management's commitment to safety culture, examples of good and bad safety culture, and the role of station personnel in achieving a good safety culture.

Davis-Besse will also be improving operational performance by strengthening the management and human performance barriers (thereby preventing events). The Operational Improvement Plan for Cycle 14 (Appendix D) identifies the following initiatives to improve operational performance: Organizational Effectiveness Improvement, Operations Improvement; Maintenance Improvement; Engineering Improvement; Training Improvement; Work Management Improvement; Continuous Safety Culture Improvement; Internal and External Oversight Improvement; Corrective Action Program Improvement; and Procedure Improvement.

Performance indicators and goals have been identified for each of the barriers to assess the effectiveness of the initiatives. Periodic assessments to monitor improvements in performance in safety culture will be conducted and actions adjusted as necessary to ensure that long-term goals will be achieved.

In summary, additional actions will be taken to continue to anchor improvements in safety culture and operational performance at Davis-Besse. Davis-Besse will use performance indicators and assessments of safety culture to verify that these actions are effective, and will take additional action as needed for any weaknesses that may be identified.

G. **Comparison against NRC Criteria**

The NRC and Davis-Besse have identified a number of criteria or factors for use in evaluating the readiness of Davis-Besse to restart. These include NRC's Restart Checklist and the Confirmatory Action Letter. As described in the body of this report, each of the criteria has been satisfied (or will soon be satisfied).

H. **Conclusions and Readiness to Restart**

In summary, Davis-Besse has identified the causes of the RPV head degradation; determined the extent of condition; reviewed its systems, programs, and organizations and taken appropriate corrective actions; implemented actions to improve management and human performance; and established plans to achieve further long-term and sustained improvement in performance at Davis-Besse.

Based upon the above, Davis-Besse concludes that the SSCs, programs, and personnel are ready to support safe operation. As a result, FENOC requests that the NRC approve restart of Davis-Besse.

Integrated Report to Support Restart of the Davis-Besse Nuclear Power Station

I. Purpose

The Davis-Besse Return to Service Plan actions necessary to ensure the safe and reliable return to service of the Davis-Besse station are almost complete. These actions include those necessary to address the six sets of commitments in the CAL, the near-term corrective and preventive actions necessary to address the causal factors associated with the RPV head degradation, and longer-term actions necessary to ensure that the underlying causal factors remain corrected and that continued performance is sustained. This Integrated Restart Report documents the basis for this determination.

II. Description and Event Chronology

A. Event Chronology

On February 16, 2002, Davis-Besse began its 13th refueling outage (13RFO), which included inspections of the RPV head CRDM nozzles in accordance with NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles." On February 27, 2002, the NRC was notified that CRDM Nozzles 1, 2, and 3 exhibited axial through-wall indications. Davis-Besse decided to repair these three nozzles and two other nozzles with crack indications that did not appear to be through-wall. On March 5, 2002, during the repair activities on CRDM Nozzle 3, it was determined that CRDM Nozzle 3 had tilted and was resting against an adjacent nozzle flange, which indicated a potential loss of RPV head material.

On March 6, 2002, an investigation was initiated to identify the cause of the CRDM Nozzle 3 displacement. A cavity in the RPV head material was discovered on the downhill side of CRDM Nozzle 3. In addition, a small cavity was identified in the RPV head during CRDM Nozzle 2 repair activities. Videotape inspections also showed a small area of corrosion where Nozzle 1 penetrates the RPV top head surface.

B. NRC's and Davis-Besse's Response to the Event

On March 13, 2002, the NRC issued CAL No. 3-02-001 regarding the RPV head degradation at Davis-Besse. The CAL documented six sets of commitments that Davis-Besse was required to fulfill prior to restart. These commitments included:

- Quarantining of components or other material from the RPV head;
- Assessing the safety significance of the RPV head degradation;
- Determining the root cause of the RPV head degradation;
- Evaluating and dispositioning the extent of condition throughout the RCS;

- Obtaining NRC review and approval of the repair or modification and testing plans for the RPV head, prior to implementation of those activities; and

- Providing plans and schedule for completing and submitting to the NRC Davis-Besse's assessment of the safety significance of the RPV degradation.

Subsequently, on May 15, 2002, the NRC revised the CAL to address FENOC's decision to replace, rather than repair, the RPV head.

In response to the event and the CAL, Davis-Besse provided the NRC with an assessment of the safety significance of the event (letter Serial Number 1-1268, dated April 8, 2002, supplemented by letter Serial Number 2968, dated August 13, 2003), performed various root cause analyses and assessments related to the event (summarized in Section III below), and developed a Return to Service Plan (summarized in Section IV.A below). That Plan described:

- Actions necessary to address each of the commitments in the CAL;

- Near-term corrective and preventive actions necessary to address the causal factors associated with the RPV head degradation event and determine their extent of condition; and

- Longer-term actions necessary to assure that the underlying causal factors remain corrected and that continued safe performance at Davis-Besse is sustained.

On April 29, 2002, the NRC informed FENOC that it would implement an IMC 0350 Oversight Panel to coordinate the agency's activities in assessing the performance problems associated with the corrosion damage to the Davis-Besse RPV head, monitor corrective actions, and evaluate the readiness of the plant to resume operations. The Oversight Panel also developed a restart checklist, which identifies those issues requiring resolution before considering a recommendation for restarting Davis-Besse. The restart checklist was first issued on August 16, 2002, and has been revised several times.

III. Root Cause Analyses and Assessments

Since discovery of the Davis-Besse RPV head degradation in March 2002, FENOC as well as other nuclear industry organizations have performed a number of root cause analyses and assessments. These analyses and assessments go far beyond the CAL commitment of determining the root cause of the RPV head degradation in that they also evaluate the organizational deficiencies that allowed the degradation to proceed without detection.

This section of the Integrated Restart Report discusses the most significant of those analyses and assessments associated with NRC's IMC 0350 Restart Checklist Items 1.a and 1.b. Those analyses and assessments are:

- Root Cause Analysis Report, "Significant Degradation of the Reactor Pressure Vessel Head; CR 2002-0891, dated 3-8-2002" (Technical Root Cause Analysis Report) (April 15, 2002 and supplemented on August 27, 2002);

- Root Cause Analysis Report, "Failure to Identify Significant Degradation of the Reactor Pressure Vessel Head; CR 02-0685, 02-0846, 02-0891, 02-1053, 02-1128, 02-1583, 02-1850, 02-2584, and 02-2585" (August 13, 2002);

- Root Cause Analysis Report, "Failure in Quality Assurance Oversight to Prevent Significant Degradation of Reactor Pressure Vessel Head; CR 2002-02578, dated 6-13-2002" (Quality Assurance Oversight Root Cause Analysis Report) (September 10, 2002);

- Root Cause Analysis Report, "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 02-2581" (Operations Root Cause Analysis Report) (November 22, 2002);

- "Evaluation of Corporate Management Issues Arising from Degradation of the Reactor Pressure Vessel Head" (December 18, 2002);

- Root Cause Analysis Report, "Ineffective Corrective Action Problem Resolution Human Performance and Implementation; CR 02-04884, Dated 8-23-02" (Corrective Action Program Root Cause) (November 26, 2002);

- "Assessment of Company Nuclear Review Board" (August 13, 2002);

- "Root Cause Analysis Report: Assessment of Engineering Capabilities" (Engineering Root Cause Analysis) (April 9, 2003); and

- "Collective Significance Review of the Causal Factors Associated with the Reactor Pressure Vessel Head Degradation at Davis-Besse" (Collective Significance Review) (March 17, 2003).

Each of these assessments is summarized below.

A. Technical Root Cause Analysis Report

The Root Cause Analysis Report, "Significant Degradation of the Reactor Pressure Vessel Head," was originally issued on April 15, 2002 and supplemented on August 27, 2002. The NRC inspected this report and found it to be adequate. As a result, the NRC closed the associated Restart Checklist items and CAL item in a letter dated September 19, 2003, stating that "the overall assessment was of appropriate depth and breadth to develop actions to correct and prevent recurrence of the management and human performance deficiencies associated with the reactor head degradation." The technical root cause analysis is summarized below.

1. Methodology

The Root Cause Analysis Report, "Significant Degradation of the Reactor Pressure Vessel Head," is referred to as the "technical" Root Cause Analysis Report because it focuses on the hardware deficiencies rather than the personnel and management deficiencies. Davis-Besse chose to first perform a technical root cause analysis followed by a management and human performance root cause analysis because of the complexity of the issues involved. By addressing each issue separately, the industry experts on each review team were able to focus on their respective issue.

A team of employees from Davis-Besse, Perry, and Beaver Valley prepared the technical Root Cause Analysis Reports. Nuclear power industry experts provided additional technical expertise. The team's objective was to conduct a prompt and thorough investigation into the primary causes of the damage to the Davis-Besse RPV head.

The Root Cause Analysis team employed a number of methodologies in the course of this investigation, including:

- Event and Causal Factors Charting;
- Procedure Review/Analysis;
- Difference Analysis; and
- Barrier Analysis.

This report was submitted to the NRC on April 18, 2002, by letter Serial Number 1-1270. On May 7, 2002, FENOC management met with the NRC in Rockville, Maryland, to discuss the results of this report.

2. Results

The Technical Root Cause Analysis Report identified the following probable root causes and contributing causes of the Davis-Besse RPV head degradation.

Probable Root Causes

- Material Selection – PWSCC in the CRDM nozzle interface at the J-groove weld due to material susceptibility in the presence of a suitable environment resulted in CRDM nozzle crack initiation, CRDM nozzle crack propagation led to through-wall leak of boric acid and boric acid corrosion occurred in the low-alloy steel RPV head material.

- Programs/Program Implementation – Inadequacies in the BACC and ISI programs and their implementation resulted in failure to identify the through-wall crack/leak during outages.

Contributing Causes

- Environmental Conditions – The design of the RPV head, which remained uncorrected through deferral of proposed modifications, and the high-radiation environment surrounding it, restricted access to the RPV head and resulted in failure to identify the through-wall crack/leak during outages.

- Maintenance and Testing – Corrective maintenance did not promptly correct the problem with equipment condition, which resulted in failure to identify the through wall-crack/leak during outages.

The NRC concluded that the analysis presented a “plausible scenario of the [RPV head] degradation” and closed the associated Restart Checklist item in Inspection Report 50-346/03-04.

As discussed in subsequent sections of this report, Davis-Besse has taken a number of comprehensive corrective actions to address these issues. These actions include replacement of the RPV head (Section IV.B), modification of the RPV service structure to facilitate inspections of the RPV head (Section IV.B), improving the BACC and ISI programs (Section IV.D), and improving corrective actions (Section IV.D).

B. Root Cause Analysis Report, “Failure to Identify Significant Degradation of the Reactor Pressure Vessel Head”

1. Methodology

The Technical Root Cause Analysis Report identified a number of issues, including several related to Davis-Besse management. Subsequently, the Root Cause Analysis Report, “Failure to Identify Significant Degradation of the Reactor Pressure Vessel Head,” dated August 13, 2002, was prepared to identify the root causes and contributing causes of the issues associated with the failure to identify the corrosion of the RPV head.

The Root Cause Analysis Report team consisted largely of employees from Perry, Beaver Valley, and Davis-Besse who were qualified in conducting assessments and root cause analyses. The team was augmented with independent experts in conducting root cause analyses and assessments of nuclear power plants.

This investigation broadly evaluated facts and focused on the underlying management, human performance, and organizational causes of the events. The team used Event and Causal Factors Analysis, Management Oversight and Risk Tree Analysis, and Hazard-Barrier-Target Analysis to perform the investigation.

The results of this report were presented to the NRC at a public meeting on August 15, 2002, at NRC's Region III office in Lisle, Illinois. This report was subsequently submitted to the NRC on August 21, 2002, by letter Serial Number 1-1286.

2. Results

The Root Cause Analysis Report identified the following root causes and contributing causes of the failure to have earlier identified the Davis-Besse RPV head degradation.

Root Causes

- Nuclear Safety Focus – A production focus established by management, combined with taking minimum actions to meet regulatory requirements, resulted in acceptance of degraded conditions on the RPV head and other components affected by boric acid.

- Implementation of the Corrective Action Program – Implementation of the Corrective Action Program was less than adequate, as indicated by addressing symptoms rather than causes; low categorization of conditions through the CR process; and less than adequate cause determinations, corrective actions, and trending.

- Analyses of Safety Implications – Failure to integrate and apply key industry information and site knowledge/experience, effectively use vendor expertise, and compare new information to baseline knowledge led to less than adequate analyses and decision-making with regard to the nuclear safety implications of boric acid on the RPV head and in the containment.

- Compliance with BACC Procedure and Inservice Inspection Program – Contrary to the requirements of these programs, boric acid was not completely removed from the RPV head. The affected areas were not inspected for corrosion and leakage from nozzles and the sources of the leakage were not determined.

Contributing Causes

- Lack of Hazard Analyses – Evaluations and decisions were made without hazards analyses that may have led to the identification of the RPV head nozzle leakage.

- Corrective Action Program Procedure – The CAP Procedure had provisions that did not reflect state-of-the-art practice in the industry, which may have allowed less than adequate corrective actions.

As discussed in subsequent sections of this report, numerous corrective actions were developed, coordinated, and implemented using the Management and Human Performance Excellence Plan. These actions include improvements in safety culture (Section V.A.2), improvements in corrective actions (Section IV.D), improvements in analysis and decision-making (Section V.A.3), and improvements in procedure compliance (Section V.A.5).

The NRC reviewed this root cause analysis and concluded that "the completed reviews were appropriately conducted and provided meaningful insights." NRC also concluded that the "planned corrective actions, if properly implemented, are sufficient to address the issues identified in the [root cause report]." As a result, the NRC closed the associated Restart Checklist item in Special Inspection Report 2002018 (Davis-Besse letter number Log 1-4420).

C. Root Cause Analysis Report, "Failure in Quality Assurance Oversight to Prevent Significant Degradation of Reactor Pressure Vessel Head"

1. Methodology

Davis-Besse CR 02-02578 identified the failure of Quality Assessment (QA) oversight to prevent significant degradation of the RPV head. FENOC subsequently formed a team to perform a root cause analysis of this issue. The focus of this investigation was to understand the key aspects of the operation of the oversight function at Davis-Besse and why it did not cause positive change in the site line organization such that the RPV head degradation would have been found at a much earlier stage. The team issued its Root Cause Analysis Report, "Failure in Quality Assurance Oversight to Prevent Significant Degradation of Reactor Pressure Vessel Head," on September 10, 2002. This report was submitted to the NRC on January 9, 2003, by letter Serial Number 1-1299.

The investigation spanned the period from late 1986 until the discovery of the RPV head degradation in early 2002. The team developed over 400 facts and observations gathered from the following sources: QA audit and surveillance reports; QA summary reports; Independent Safety Engineering Group reports and correspondence; NRC inspection reports and correspondence; personnel interviews; and miscellaneous documents developed from other sources.

2. Results

The team concluded that the QA oversight function missed earlier opportunities to identify and mitigate the RPV head degradation. The root cause was determined to be that Davis-Besse's nuclear safety values, behaviors and expectations were such that oversight was not set apart, in terms of expectations and performance standards, from the balance of the station. This affected the ability of the oversight organizations to identify problems and implement changes in station operations and standards.

As discussed in subsequent sections of this report, a number of corrective actions have been taken to address these issues. These actions include enhancing the independence and visibility of QA (Section V.A.4).

The NRC reviewed this root cause analysis and concluded that the "overall assessment was of appropriate depth and breadth to develop actions to correct and prevent recurrence of the management and human performance deficiencies associated with the reactor head degradation." The NRC also concluded: "if properly implemented and monitored, the corrective actions will appropriately address the issues identified in the [root cause analysis]." As a result, the NRC closed the associated Restart Checklist item in Special Inspection Report 2002018 (Davis-Besse letter number Log 1-4420).

D. Operations Root Cause Analysis Report

Condition Report 02-02581 was generated to address the apparent lack of involvement of the Davis-Besse Operations section in the issues related to the RPV head degradation. An analysis was performed by a team consisting of two independent consultants who specialize in performing root cause analyses and assessments of nuclear power plant organizational performance, and a senior member of the Davis-Besse Operations section. The purpose of the analysis was to identify the root and contributing causes of the previous lack of Operations' involvement in maintaining, assuring, and communicating the operational safety focus of Davis-Besse and the lack of accountability of other groups to Operations in fulfilling that leadership role. Based upon its analysis, the Operations Root Cause Team identified one root cause and three contributing causes for the erosion of Operations' leadership in station activities. This report was submitted to the NRC on January 9, 2003, by letter Serial Number 1-1299.

Root Cause

- Senior management support for Operations' leadership role in assuring plant safety was lacking.

Contributing Causes

- Staffing was inadequate to perform the tasks assigned;
- Senior management failed to ensure that regulatory expectations for licensed personnel were effectively communicated and reinforced; and
- Senior management failed to assure that a SCWE was established and maintained in Operations.

As discussed in subsequent sections of this report, a number of corrective actions have been taken to address these issues. These actions include development of an Operations Leadership Plan, training of Operators on their regulatory responsibilities, and a staffing plan.

The NRC reviewed this root cause analysis and concluded that the "overall assessment was of appropriate depth and breadth to develop actions to correct and prevent recurrence of the management and human performance deficiencies associated with the reactor head degradation." The NRC also concluded: "if properly implemented and monitored, the corrective actions will appropriately address the issues identified in the [root cause analysis]." As a result, the NRC closed the associated Restart Checklist item in Special Inspection Report 2002018 (Davis-Besse letter number Log 1-4420).

E. Corporate Management Evaluation

After degradation of the RPV head was discovered in March 2002, FENOC recognized that changes should be made to the structure and focus of the corporate nuclear organization. Toward that end, an "Evaluation of Corporate Management Issues" was conducted in December 2002. The purposes of this effort were to: (1) perform an evaluation of the corporate management role relative to the issues identified in the various RPV head degradation reports and analyses; and (2) ensure that the Management and Human Performance Improvement Plan (summarized in Section V below) included the necessary and sufficient actions to address the issues related to corporate management. This evaluation was submitted to the NRC on January 9, 2003, by letter Serial Number 1-1299.

FENOC evaluated various functions that were performed or could have reasonably been performed by corporate management with respect to the RPV head, including corporate management involvement; policies on safety; adequacy of resources; incentive programs; common processes for FENOC nuclear plants; sharing of information among FENOC plants; and corporate assessments (including QA and the Company Nuclear Review Board).

Issues from the root cause analyses and other assessments were collected and assigned to one or more of the functions, as applicable. For each function, the identified issues were evaluated, similar issues were combined, and a consolidated list of issues for each corporate management function was developed. For each issue on the consolidated list, a review was performed to determine whether the Management and Human Performance Improvement Plan contained an appropriate action to address the issue.

The Improvement Plan included actions that addressed the issues arising from the assessments of the Davis-Besse RPV head degradation that have implications for FENOC corporate management. In several cases, FENOC was taking or planning to take additional actions to improve corporate management that were not explicitly discussed in the Plan. The Management and Human Performance Improvement Plan was subsequently revised to discuss those actions.

The NRC reviewed this evaluation and concluded that the "overall assessment was of appropriate depth and breadth to develop actions to correct and prevent recurrence of the management and human performance deficiencies associated with the reactor head degradation." The NRC also concluded: "if properly implemented and monitored, the corrective actions will appropriately address the issues identified in the [evaluation]." As a result, the NRC closed the associated Restart Checklist item in Special Inspection Report 2002018 (Davis-Besse letter number Log 1-4420).

F. Corrective Action Program Root Cause Analysis

The Root Cause Analysis Report described above in Section III.B found that the CAP failed to identify the corrosion problem even though numerous symptoms were identified and documented within the CR process. The CAP was also reviewed as a part of the Program Compliance Plan (summarized in Section IV.D below) that also found deficiencies with CAP implementation. As a result, this analysis was performed to determine the root causes of those problems with the CAP.

The analysis identified two root causes for the CAP deficiencies. One root cause was less than adequate managerial methods — site personnel exhibited insufficient awareness of the impact of conditions on safety and reliability and a lack of self-critical and questioning attitudes within the Davis-Besse organization.

The second root cause also concerned less than adequate managerial methods in that expectations regarding the CAP were not well-defined or understood. Past failures of senior management to convey clear expectations in support of the CAP, establish appropriate standards of CAP performance, and align organizational goals within the Davis-Besse staff caused a loss of organizational commitment to the FENOC vision for the corrective action process. This report was submitted to the NRC on January 9, 2003, by letter Serial Number 1-1299.

As discussed in subsequent sections of this report, a number of corrective actions have been taken to address these issues. These actions include improvements in safety culture (Section V.A.2) and to the CAP (Section IV.D).

The NRC reviewed this root cause analysis and concluded that the "overall assessment was of appropriate depth and breadth to develop actions to correct and prevent recurrence of the management and human performance deficiencies associated with the reactor head degradation." The NRC also concluded: "if properly implemented and monitored, the corrective actions will appropriately address the issues identified in the [root cause analysis]." As a result, the NRC closed the associated Restart Checklist item in Special Inspection Report 2002018 (Davis-Besse letter number Log 1-4420).

G. <u>Assessment of the Company Nuclear Review Board</u>

In August 2002, FENOC issued a report by an independent contractor entitled "Assessment of the FENOC Company Nuclear Review Board," which assessed the CNRB's past and future oversight role as it relates to the missed opportunity to identify the Davis-Besse RPV head degradation. The assessment focused on reviewing the information provided to the CNRB, the information available to the CNRB, and the CNRB's responses to that information. This assessment was submitted to the NRC on January 9, 2003, by letter Serial Number 1-1299.

The assessment found that CNRB members received enough plant-specific information to have suggested a concern with ongoing degradation of the Davis-Besse RPV head. In view of the alerts received from other industry organizations and the NRC, CNRB should have raised questions regarding boric acid corrosion of the RPV head.

As discussed in subsequent sections of this report, a number of corrective actions have been taken to address these issues. These actions included the issuance of FENOC operating administrative procedure, NOP-LP-2006, "Company Nuclear Review Board," which requires the CNRB to focus on safety issues.

The NRC reviewed this assessment and concluded that the "overall assessment was of appropriate depth and breadth to develop actions to correct and prevent recurrence of the management and human performance deficiencies associated with the reactor head degradation." The NRC also concluded: "if properly implemented and monitored, the corrective actions will appropriately address the issues identified in the [assessment]." As a result, the NRC closed the associated Restart Checklist item in Special Inspection Report 2002018 (Davis-Besse letter number Log 1-4420).

H. Engineering Root Cause Analysis Report

In December 2002, FENOC commissioned an independent industry team to perform an assessment of the Davis-Besse Engineering organization. The objective of the assessment was to evaluate the organizational effectiveness of the Engineering organization and the capability of that organization to support safe plant operation and to identify potential areas for improvement. On January 3, 2003, “Root Cause Analysis Report; Assessment of Engineering Capabilities,” was issued. This report was submitted to the NRC on January 9, 2003, by letter Serial Number 1-1299.

This report was subsequently revised and reissued on April 9, 2003, to address issues identified during an internal Restart Readiness Review of Engineering that was conducted in March 2003. The revised report was submitted to the NRC on May 2, 2003, by letter Serial Number 1-1314.

The analysis determined that the primary cause concerned managerial methods and the process used to control or direct work-related plant activities. The analysis also made a number of observations, including:

- Key Engineering positions were open.
- Many Engineering roles and responsibilities were either misunderstood or undefined.
- Management should provide consistent coaching to the staff to reinforce expected behaviors.
- Lessons learned from the Engineering review and assessment were not captured and catalogued for use by other FENOC personnel.
- Many plant deficiencies identified during the Containment Health, System Health, and LIRs were previously identified but were not properly addressed.

As discussed in subsequent sections of this report, a number of corrective actions have been taken to address these issues. These actions include filling key management and supervisory Engineering positions with experienced personnel, including the Manager – Plant Engineering (Section V.A.1), establishing standards and expectations for Engineering personnel (Section V.A.3), establishing a Management Observation Program (Section V.A.1), establishing an Engineering Assessment Board (Section V.A.4), and improving corrective actions (Section IV.D).

The NRC reviewed this report and concluded that the “overall assessment was of appropriate depth and breadth to develop actions to correct and prevent recurrence of the management and human performance deficiencies associated with the reactor head degradation.” The NRC also concluded: “if properly implemented and monitored, the corrective actions will appropriately address the issues identified in the [root cause analysis].” As a result, the NRC closed the associated Restart Checklist item in Special Inspection Report 2002018 (Davis-Besse letter number Log 1-4420).

I. Collective Significance Review

On March 17, 2003, Davis-Besse issued the "Collective Significance Review of the Causal Factors Associated with the Reactor Pressure Vessel Head Degradation at Davis-Besse" and which was submitted to the NRC on March 27, 2003, by letter Serial Number 1-1306. This report provided the results of a collective evaluation of the numerous assessments associated with the RPV head degradation. The review provided an integrated, collective significance review of identified causes associated with organizational or managerial issues, and identified many underlying factors or global issues not previously identified, or not identified as being significant, by the individual sources alone. In addition to the many root cause analyses reviewed for the report, a number of other documents were reviewed, including internal assessments, NRC inspection reports, and CRs.

The Collective Significance Review identified the predominant common causes of RPV head degradation: Management/Supervisory Methods; Culture or Environment, Corrective Actions; and Work Practices.

The Collective Significance Review also identified three other "cause themes" that were not specifically identified (in these terms), or previously identified as being significant, in the individual documents reviewed: written procedures and documents; technical competency; and cross-functional organizational effectiveness.

The Collective Significance Review also found that corrective actions previously identified in the individual documents were far-reaching and broad enough to adequately address these "new" issues; consequently, no further actions were determined to be necessary.

The NRC reviewed this assessment and concluded that the "overall assessment was of appropriate depth and breadth to develop actions to correct and prevent recurrence of the management and human performance deficiencies associated with the reactor head degradation." The NRC also concluded: "if properly implemented and monitored, the corrective actions will appropriately address the issues identified in the [review]." As a result, the NRC closed the associated Restart Checklist item in Special Inspection Report 2002018 (Davis-Besse letter number Log 1-4420).

J. Conclusion

Since March 2002, Davis-Besse, as well as several external industry organizations, have performed a number of extensive root cause analyses and assessments concerning the RPV head degradation. These analyses and assessments identified both the technical and organizational causes of the RPV head degradation and the failure of Davis-Besse personnel and oversight to detect the degradation in a timely manner. NRC has inspected these assessments and found them to be adequate and that they provided a solid foundation for the performance of corrective actions. As a result, the NRC closed the associated Restart Checklist items 1a, 1b, and 4a in Inspection Reports 50-346/03-04 and 02-18, and the associated CAL item in a letter dated September 19, 2003.

IV. Return to Service Plan and Building Block Plans

A. Return to Service Plan

To guide Davis-Besse's course of action for a safe and reliable return to service, Davis-Besse developed and implemented a Return to Service Plan. The Plan included those actions necessary to address each of the commitments in the CAL, the near-term corrective and preventive actions necessary to address the causal factors associated with the RPV head degradation, and the longer term actions necessary to assure that the underlying causal factors remain corrected and that continued safe performance at Davis-Besse is sustained.

The Return to Service Plan includes seven Building Blocks designed to support safe and reliable restart of the plant and to ensure sustained performance improvements. The seven Building Blocks and associated charters are:

- Reactor Head Resolution Plan – replace the degraded RPV head with an unused one from the canceled Midland Plant.

- Containment Health Assurance Plan – perform inspections and evaluations of containment SSCs and ensure completion of required remediation activities prior to restart.

- System Health Assurance Plan – perform reviews of system health prior to restart to ensure that the condition of the plant is sufficient to support safe and reliable operation.

- Program Compliance Plan – perform a review of applicable plant programs to ensure that the programs are fulfilling required obligations, including interfaces and handoffs, and are sufficient to support the restart and safe operation of Davis-Besse.

- Management and Human Performance Excellence Plan – conduct a thorough assessment of the management and organizational issues surrounding the degradation of the RPV head and initiate a substantive and demonstrable change in Davis-Besse management and human performance.

- Restart Test Plan – perform restart testing necessary to ensure the integrity of the RCS and the containment pressure vessel, evaluate proposed testing of systems and components affected by RCS leakage and boric acid deposits, and develop an Integrated Restart Procedure to ensure that proper sequencing of required restart activities is accomplished prior to mode ascension.

- Restart Action Plan – administer the identification, coordination, monitoring and closure of actions required to meet all Company-identified objectives and requirements under the Davis-Besse Return to Service Plan.

Each of these Building Block Plans and the results of their implementation are described in the following sections. Additionally, Section IV.I below describes the results of the review to verify the completeness and accuracy of correspondence submitted to the NRC.

FENOC executive leadership has been directly involved in the direction and oversight of Davis-Besse's return to service. The following have been the key elements of the restart organization:

- The FirstEnergy CEO and FENOC President have been active players at Davis-Besse.

- The new FENOC President has spent a substantial portion of his time at Davis-Besse.

- A new Chief Operating Officer position was established and assigned to provide corporate direction and oversight of the Return to Service Plan.

- A new position, Vice President – Engineering and Services, was established to provide corporate direction and oversight of Engineering activities under the Return to Service Plan.

- A new position, Vice President – Oversight, was created to provide independent oversight of FENOC activities.

- A new site Vice President and Plant Manager were appointed.

- An EAB was established to review and reinforce higher and consistent standards for engineering and other selected technical documents, including products generated under several of the Building Blocks. The EAB included a Program Review Board.

- The SLT (which was previously named Senior Management Team (SMT)) was established, consisting of the FENOC Chief Operating Officer, the site Vice President, the Plant Manager, the Directors representing Nuclear Engineering, Support Services, Restart, and Maintenance. The SLT provided senior management review and oversight of restart activities.

- A Restart Station Review Board (RSRB), consisting of the Director of Support Services, and site managers, was chartered to identify and classify items to be corrected prior to restart through a review of CRs, Corrective Actions, work orders, and engineering change requests.

- A Restart Overview Panel (ROP), which includes independent industry experts, community representation, and FENOC executives, some of whom have extensive experience in recovery efforts at plants with long outages, was established to provide additional oversight and review of plant activities discovered or performed as part of the Return to Service Plan Building Blocks.

The ROP is responsible for making a recommendation on whether the plant is ready for restart.

Davis-Besse NQA, reporting to the Vice President – Oversight, has provided oversight and assessed key activities such as: observation of review board meetings; review of engineering products; field verification of actual conditions pre- and post-remediation; and independent reviews paralleling those performed by the line organization. Based upon these assessments, NQA verified the adequacy of activities conducted as part of the Return to Service Plan.

As described in the following sections, formal plans were developed for each of the seven Building Blocks, along with implementing procedures and action plans where appropriate.

B. Reactor Head Resolution Plan

The degraded Davis-Besse RPV head was replaced with an unused one from the canceled Midland Plant. The Reactor Head Resolution Plan building block was the project plan for performing that replacement. Its charter was to restore the degraded Davis-Besse RPV Head such that it is in full compliance with appropriate Commission rules and industry requirements.

As described in more detail below, the replacement RPV head and restored containment vessel and shield building provide an adequate level of safety and are in compliance with applicable NRC and industry requirements. Consequently, the RPV and containment are ready to support restart and safe operation.

The major attributes of the Reactor Head Resolution Plan included:

- Procurement and certification of the replacement RPV head;
- Implementing minor modifications to the replacement RPV head to ensure that it fit the Davis-Besse reactor;
- Cutting access openings in the shield building and containment vessel for removal of the original RPV head and insertion of the new RPV head;
- Installation of the new RPV head, including transfer of the existing service structure (with inspection access opening modifications to the RPV head service structure support skirt) and transfer of the existing CRDMs;
- Restoration, testing, and inspection of the RPV head and containment;
- Temporary storage and disposal of the original Davis-Besse RPV head; and
- Updating the design and licensing basis documents.

1. Replacement of Reactor Vessel Head

a. Project Scope

The Midland RPV head was purchased from Framatome ANP (Framatome), which had purchased it from Consumers Energy, the owner of the Midland Plant. The Midland RPV head was an ASME Code Section III Class A component, certified with an ASME Code N-stamp. Framatome provided the required documentation, supplemental examinations, analyses, and ASME Code reconciliation necessary to ensure the original ASME Code N-stamp documentation remains valid, and that the replacement RPV head complies with appropriate NRC and industry requirements.

Framatome’s activities included modifying the RPV head, providing a Certificate of Conformance documenting that the replacement RPV head is suitable for use at Davis-Besse, and providing engineering and other required evaluations to ensure the Davis-Besse design and licensing requirements (including ASME Code criteria) are met. In addition, Bechtel was contracted to provide engineering services for the RPV head replacement, including overall project management, detailed engineering, licensing support, quality assurance, and project controls.

b. Description of Major Activities

(1) Procurement and Certification of the Replacement RPV Head

The replacement RPV head was procured under the provisions of 10 CFR Part 21. Like the original Davis-Besse RPV head, the Midland RPV head was manufactured to the ASME Code, Section III, 1968 Edition, Summer 1968 Addenda. Following its manufacture, the Midland RPV head was hydrostatically tested at 3,125 psig in accordance with ASME Code requirements. After the Midland Plant was canceled, however, the RPV head was not maintained under a 10 CFR Part 50, Appendix B, quality assurance program. In addition, Davis-Besse was unable to obtain all the original construction radiography for the Midland RPV head and was unable to perform radiography of all the flange welds due to the presence of the lifting lugs on the head.

To resolve these nonconformances, Davis-Besse submitted letter Serial Number 2797 on August 1, 2002, requesting relief from conformance with certain ASME Code requirements. Supplemental information was provided to the NRC on September 23, 2002 by letter Serial Number 2809. In the first request, RR-A26, it was proposed, as an alternative to the ASME Code construction record requirements, to maintain the following records: (1) the original Code Data Form showing the construction activities performed; and (2) supplemental radiographic examinations of the replacement RPV head-to-flange weld and the 69 CRDM nozzle body-to-flange welds.

In the second request, RR-A27, it was proposed, as an alternative to the ASME Code requirement for a full radiograph of the RPV head-to-flange weld, to use the Manufacturer's Data Report for Nuclear Vessels - Form N-1A (Code Data Form). This form states that the RPV head conforms to the ASME Code requirements. In addition, supplemental radiographic examination records performed in 2002 (that examined approximately 95 percent of the replacement RPV head-to-flange weld) supported satisfying the ASME Code requirements. On December 13, 2002, the NRC approved the two relief requests (Davis-Besse letter Log 6037).

Framatome performed the non-destructive examinations (NDEs) described above and provided certification that the replacement RPV head meets ASME Code requirements, as modified by the two relief requests discussed above. These activities included assembling and assessing existing documentation related to the replacement RPV head, performing additional NDE tests (including ISI examinations, as necessary), and analyses of the Certificate of Conformance and other documentation to ensure acceptability of the replacement RPV head. Framatome performed additional NDEs to confirm the integrity of the RPV head.

Similar to the original RPV head for Davis-Besse, the replacement RPV head has penetrations made of Alloy 600. Because the replacement RPV head is unused, however, it currently has low susceptibility to PWSCC. Longer term, Davis-Besse plans to replace the current RPV head with a new head that uses a material that has less susceptibility to PWSCC.

(2) Shield Wall Demolition

To accommodate removal of the original RPV head and installation of the replacement, a 16.5 feet high by 21.5 feet wide access hole was cut in the containment shield building wall. The opening was made using a "hydro demolition" (high-pressure water jet) technique to remove the concrete. This high-pressure water jet process left the original rebar intact and undamaged. The shield building wall rebar was then torch-cut and removed.

(3) RPV Head Modifications

Several modifications were made to the Midland RPV head prior to its installation on the Davis-Besse RPV. The original Davis-Besse reactor service structure was mounted on the Midland RPV head service structure support skirt and inspection ports were installed on the Midland RPV head support skirt to facilitate future RPV head inspections at Davis-Besse. In addition, minor differences in the Midland RPV head O-ring grooves required the installation of new O-rings with a smaller diameter. Minor machining of the vessel-to-head keyway surfaces was performed to ensure a proper fit.

In addition, the pre-existing Davis-Besse CRDMs are being reused on the replacement RPV head; no modifications to the CRDM position locations were required. The CRDM flange index pins were modified to ensure proper mating of the CRDM flange joint with the pre-existing Davis-Besse CRDMs. The CRDM split nut rings were also modified to facilitate maintenance and to improve the leak-tight integrity of the flanged joint.

Framatome also performed an ASME Code reconciliation pursuant to ASME Code Section XI (as a repair/replacement activity). Under the provisions of 10 CFR § 50.59 as detailed in Engineering Work Request (EWR) 02-0217-00, "Reactor Vessel Head Replacement and Associated Service Structure Modifications," these modifications were minor and did not involve any changes to the Davis-Besse Operating License or Technical Specifications. Consequently, these activities did not require prior NRC approval.

(4) Restoration, Inspection, and Testing of the RPV Head and Containment

Framatome transferred the existing service structure and CRDMs onto the new RPV head utilizing Davis-Besse-approved procedures and processes. The lower service structure and upper support skirt flanges were match drilled for the replacement RPV head. After verifying alignment, the two components were welded utilizing Davis-Besse-approved procedures.

The Davis-Besse containment vessel and shield building were returned to their original design configurations by reinstalling the cut sections of rebar with rebar splices and/or rewelding rebar, as necessary, and by placing safety-related concrete to restore shield building integrity. The restoration activities were conducted in accordance with the design requirements, thus ensuring that the containment vessel and shield building are capable of performing their intended functions. Post modification testing included a local leak rate test of the repair of the containment vessel and an ILRT of the containment. This testing verified that the containment vessel was in compliance with the design and testing requirements of ASME and other industry standards. Additionally, the ILRT was successfully performed at a pressure that exceeded the design basis pressure, thereby demonstrating additional margin for Davis-Besse.

The RCS was filled and vented, and a visual inspection was performed to look for any evidence of leakage. The plant was brought to normal operating conditions (approximately 2,155 psig) using reactor coolant pump heat. The RCS Leakage Test was performed to the requirements of Section XI of the ASME Code. A prior augmented examination occurred at 250 psig in May 2003. Both examinations used ASME Code Section XI visual examination criteria and techniques.

<u>Results of RCS Leakage During Mode 4 Normal Operating Pressure Test</u>

Davis-Besse inspected more than 1,100 components during the RCS Leakage Mode 3 NOP Test and identified potential minor leakage on approximately 130. Of these, about 100 were packing leaks, six were leaking pipe caps, and three were manifold leaks. None of these leaking components violated the ASME Code because they did not involve pressure boundary leakage. After the NOP Test was completed, insulation was removed from several RCS components to facilitate examinations of potential leakage at bolted connections; only one such bolted connection was found to be leaking. Based upon these results, no outstanding items have been identified.

(5) Updating of Design and Licensing Basis

The Davis-Besse design and licensing basis has been updated to reflect the RPV head modifications and replacement. This includes updating the Davis-Besse Design Specification, replacing Davis-Besse RPV head drawings, updating stress reports, updating the Updated Safety Analysis Report (USAR) and other documentation to maintain both the design and licensing basis and to maintain configuration management consistent with the requirements of 10 CFR Part 50.

c. Conclusion

The RPV head replacement was a modification to the facility and was performed under the provisions of 10 CFR § 50.59. The last action for closure of this Building Block was completed with the RCS pressure test in September 2003 and the final inspection. In addition, control rod drop surveillances will be performed when the plant returns to Mode 3. The replacement RPV head and restored containment vessel and shield building provide an adequate level of safety and are in compliance with applicable NRC and industry requirements. Therefore, the RPV and containment are ready to support restart.

In Inspection Report 50-346/03-05, the NRC discussed its inspection of Restart Checklist Item 2.b, "Containment Vessel Restoration Following Reactor Pressure Vessel Head Replacement." The NRC concluded that containment integrity had been restored where the containment had been opened for replacement of the RPV head. Consequently, the NRC closed Restart Checklist Item 2.b. NRC closure of Item 2.a concerning the RPV head is pending.

C. Containment Health Assurance Plan and Inspections of the Lower RPV Penetrations

The purpose of the Containment Health Assurance Plan was to perform inspections and evaluations of SSCs within containment and to ensure that the condition of containment supports safe and reliable operation. The plan focused on the extent of condition of PWSCC of Alloy 600 welds in the RCS, and identifying damage that may have resulted from boric acid leakage and dispersion of boric acid in the Containment Building. Additionally, inspections, analyses, and tests were performed to confirm that the penetrations in the bottom of the RPV were not leaking. Each of these is discussed below. The Containment Health methodology is shown in Figure 1 on page 33.

As discussed in more detail below, comprehensive inspections and evaluations of the condition of SSCs within containment were conducted. Additionally, inspections, analyses, and tests were performed to confirm that the penetrations in the bottom of the RPV were not leaking, and a number of modifications were made to recover and add safety margin as discussed in Section IV.J below. Overall, approximately 2,500 restart corrective actions related to containment health have been performed. As a result, Davis-Besse concludes that the condition of the SSCs within containment will support safe restart and operation.

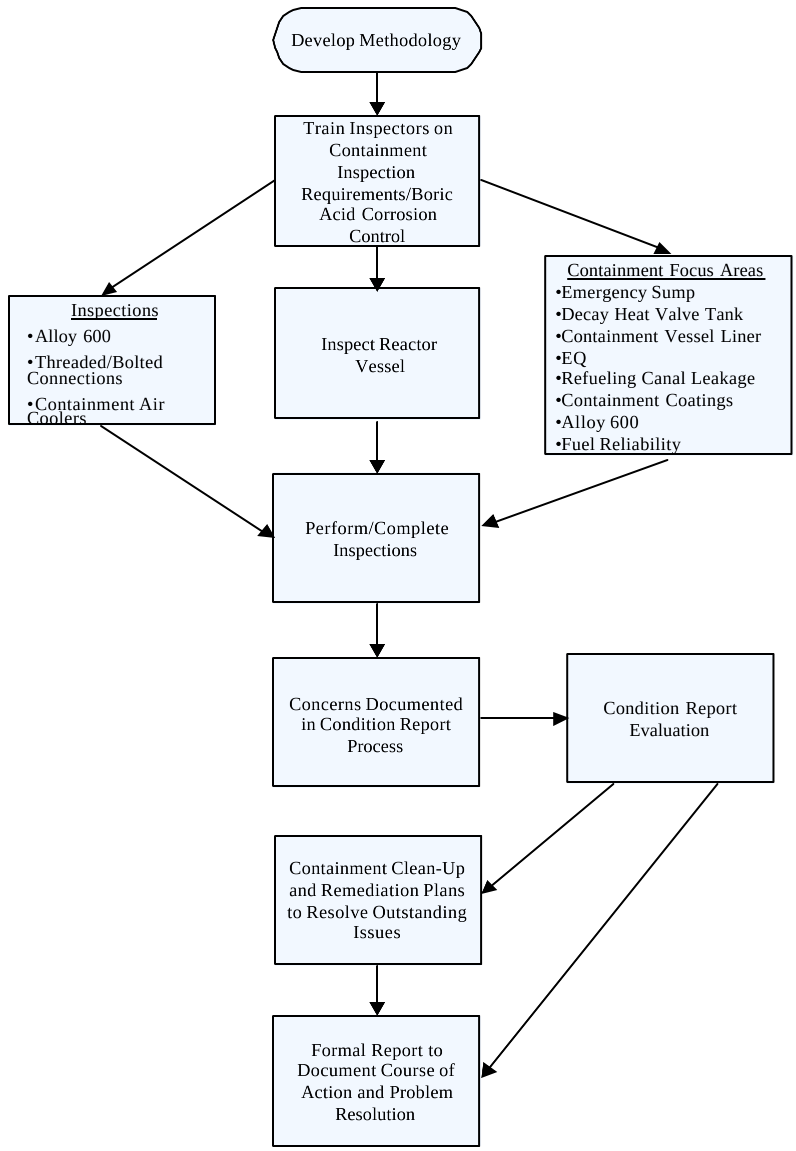
1. Inspections to Determine the Extent of Condition of PWSCC and Boric Acid Corrosion

Inspections and evaluations focused on a number of attributes and items, including:

- Boric acid-induced degradation sites;
- Containment vessel;
- Containment coatings;
- Alloy 600 material;
- Emergency Sump;
- DH Valve Pit;
- Fuel Reliability;
- PWSCC indications; and
- Threaded and bolted connections.

Action plans were developed for each of these focus areas to direct the actions necessary to meet the objectives of the plan. Procedures, work orders, and CRs were used to control field activities. Inspections were performed using qualified inspectors and evaluators. Over 1,000 CRs were generated during the inspections to document potentially adverse conditions. Additionally, the RSRB reviewed the CRs to designate restart requirements.

Figure 1 -- Containment Health Methodology



Components significantly affected by the boric acid deposition included the containment air coolers, as discussed in more detail in Licensee Event Report (LER) 2002-008. Additionally, degradation of other components such as ductwork, cable trays, conduits, and coatings was identified, and as appropriate, a number of these components were replaced or repaired. It was determined that the boric acid deposition did not impact the EQ of any equipment.

Additionally, the containment walkdowns revealed that the decay heat removal (DHR) system may not be able to maintain long-term recirculation flow because the suction screen for the containment emergency sump could become clogged by debris and because gaps in the screens could allow debris to pass through to the pump. In response, the sump has been modified to correct the problem and add safety margin (Section IV.J). Additionally, several other actions were taken, including removing materials from containment that could impact the function of the emergency sump (*e.g.*, unjacketed fibrous insulation and unqualified coatings).

2. <u>Inspections of the Lower RPV Penetrations</u>

During 13RFO in early 2002, a visual inspection was performed of the RPV beneath the flange level. This inspection identified stains consisting of boric acid residue and rust/corrosion running down the external RPV sides and the bottom. A video inspection of the RPV underside was completed in June 2002. This video inspection showed stains around several in-core monitoring instrumentation (IMI) nozzle penetrations. The majority of nozzles with stains were directly in the flowpaths. The stained deposits around the nozzle penetrations were flat and tightly adhering to the RPV surface. No indication of 'popcorn-type' boric acid deposits was observed around the nozzle penetrations. No wastage on the RPV underside was found, and no buildup of boric acid or corrosion products was found on top of the RPV underside insulation panels.

In an effort to determine the source of these stains, a number of activities were conducted, including: (1) obtaining samples of the stains and performing chemical analysis on the deposits; (2) laboratory simulation tests of IMI nozzle leakage to determine IMI nozzle leakage deposit characteristics; (3) cleaning the bottom of the RPV, pressurizing the RCS to 250 psig, and visually inspecting the IMI nozzle penetrations for indications of leakage; and (4) pressurizing the RCS during Mode 3 to approximately normal operating pressure (approximately 2,155 psig) and holding for approximately seven days, and visually inspecting the bare metal IMI nozzle penetrations following this test with a crawler video camera using procedure EN-DP-01500, "Reactor Vessel Inspection Procedure."

The results of these tests and analyses were as follows:

- In general, the nozzles in question were directly in the visible flow path of the boric acid and rust/corrosion stains down the side of the RPV identified in the spring of 2002. Furthermore, the refueling canal leakage occurrence at Davis-Besse in early 2003 indicated that nozzles can have stains as a result of flow down the side of the RPV, even though the nozzles are not in the visible flow trails.

- There were no "popcorn" deposits of boric acid at the IMI nozzles in the spring of 2002 (which would be expected if the nozzles were leaking).

- The concentrations of boron and lithium detected at the IMI nozzles in the spring of 2002 were significantly less than would be expected if the IMI nozzles were leaking.

- No indications of leakage from the IMI nozzles was observed as a result of the test at 250 psig in 2003.

- There was no indication of leakage from the IMI nozzles following the normal operating pressure test at Mode 3.

In conclusion, the inspections, analyses and testing that were performed provide reasonable assurance that the rust/corrosion stains and boric acid residue found around several IMI nozzle penetrations during the initial visual inspection did not result from leakage from the IMI nozzles.

3. Conclusion

Davis-Besse has conducted comprehensive inspections and evaluations of the condition of SSCs within containment. These inspections focused on the extent of condition of PWSCC of Alloy 600 welds in the RCS, and identifying damage that may have resulted from boric acid leakage and dispersion of boric acid in the Containment Building. These inspections and evaluations demonstrated that, with the exception of the CACs, the SSCs could perform their safety function. The CACs were replaced and numerous other components were cleaned of boric acid and repaired. Additionally, inspections, analyses, and tests were performed to confirm that the penetrations in the bottom of the RPV were not leaking, and a number of modifications were implemented to recover and add safety margin. As of November 21, 2003, approximately 2,500 restart corrective actions related to containment health have been completed, and less than five restart corrective actions remain open. As a result, Davis-Besse concludes that the condition of the SSCs within containment will support safe restart and operation. Additionally, as discussed in Section IV.J, Davis-Besse has exceeded industry standards by installing the FLÜS monitoring system, which allows Davis-Besse personnel to readily detect minute amounts of RPV bottom head leakage during normal plant operations, should leakage occur.

D. **Program Compliance Plan**

As discussed above, it was determined that program weaknesses were a contributor to the degradation of the RPV head. The program weaknesses involved standards, ownership, and oversight.

Consequently, a Program Compliance Plan was implemented to review applicable plant programs to ensure that the programs are fulfilling required obligations, including interfaces and handoffs, and are sufficient to support the restart and safe operation of Davis-Besse. As discussed below, the Plan provided for two levels of program reviews.

Phase 1 – Program Readiness Baseline Assessment

Phase 1 performed a baseline assessment of 65 plant programs to determine if the programs were in a condition to support the restart and safe operation of Davis-Besse. The program owner assessed the program by completing a standardized questionnaire. The program owner then presented the results of that assessment to a Program Review Board, which included independent, external personnel. Condition Reports were generated to document program weaknesses and recommendations. The CRs were evaluated to determine whether the corrective action should be identified as a restart restraint.

Phase 2 – Detailed Program Reviews

Phase 2 was an in-depth systematic review of specified programs. This process evaluated programs in depth to ensure that the programs are fulfilling required obligations, including interfaces and handoffs, and are sufficient to support the restart and safe operation of Davis-Besse. Phase 2 reviews were completed prior to restart for the BACC Program, ISI Program, Plant Modification Program, Corrective Action Program, Radiation Protection Program, and the Operating Experience Program. Separately, a review of the QA Audit Program was also performed. Condition Reports were generated to document program weaknesses and recommendations. The CRs were evaluated by the RSRB to determine whether the corrective action should be identified as a restart restraint. The Program Compliance organization is shown in Figure 2 on page 38.

Davis-Besse performed an assessment of the overall results of the Program Compliance reviews. The CRs generated through the detailed program reviews were assessed for collective significance and trends. The problems identified fell within three categories: (1) standards; (2) ownership; and (3) oversight. Actions have been taken to address these issues. For example, each program has an owner who monitors the program and identifies potential problems.

In addition to the CRs from the detailed program reviews, related CRs from other sources were reviewed. These included CRs generated during the baseline program assessments, by the System Health reviews, and by the general site population. Issues raised in these CRs were determined to be consistent with the results of the detailed program reviews. No new trends or previously unidentified collective significance issues were identified from the review of the data.

In total, over 600 restart corrective actions for programs have been completed. Based upon its reviews and corrective actions, and as discussed in more detail below, Davis-Besse concludes that its programs are ready to support safe and reliable operation.

1. Results – Phase 1 Programs

Deficiencies identified were documented in the Corrective Action Program. The deficiencies were categorized by the RSRB utilizing the criteria in NG-VP-00100, "Restart Action Plan Process," as restart or "non-restart related." The restart related deficiencies were corrected, the resolution reviewed and approved by the Program Review Board, and the responsible manager affirmed the readiness of the program to support return to service and safe operation. Phase 1 programs have been approved as ready to support restart. Restart actions varied widely depending on the specific program. They ranged from minor enhancements to major alterations to program ownership and implementation. Some of the more significant actions included completion of design capability calculations for Air Operated Valves and extensive user training for the Commitment Management Program.

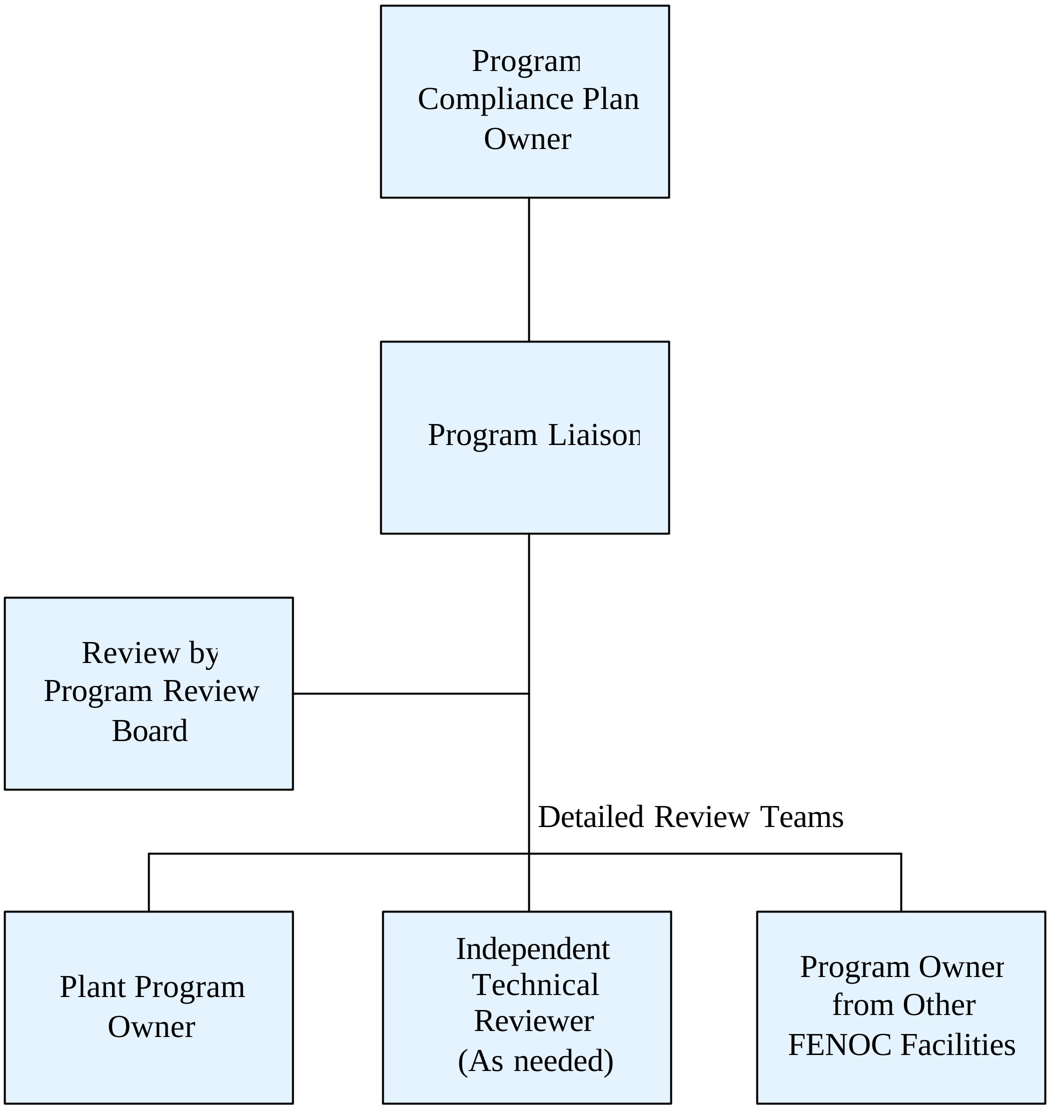
2. Results – Phase 2 Programs

a. Corrective Action Program

As part of the Program Compliance Plan, independent consultants conducted a detailed review of the CAP and its implementation. This review benchmarked the corrective action procedure against industry standards. Additionally, the CAP was reviewed to identify whether it contains appropriate provisions for ensuring the timely resolution of conditions. As a result of this review, appropriate corrective actions have been taken to address the identified weaknesses. The revised program was approved by the FENOC Executive Leadership Team and became effective on March 1, 2003. Based upon the assessments, the following improvements have been made:

- Operability Reviews – Several actions have been taken to improve reviews of the operability of SSCs with degraded and nonconforming conditions. First, at Davis-Besse, the program for performing operability evaluations has been revised to provide improved guidance and more rigor. Second, to be consistent with other FENOC plants, Davis-Besse Operations is using Engineering resources more in their initial operability evaluations. An experienced external expert has also provided training to Operations and Engineering personnel on operability evaluations.

Figure 2 -- Program Compliance Organization Chart



- Improvements in Condition Categorizations – The Management Review Board now reviews categorization of the CRs to ensure their adequacy.

- Improvements in Cause Determinations – A Problem Resolution Process used at other FENOC stations has been implemented at Davis-Besse. The corrective action procedure was revised to require the use of formal cause determination techniques for conditions in the more significant categories to ensure that sufficient analytical rigor is applied to the analyses. A tiered approach to the number and type of techniques applied was developed. Additionally, training requirements were defined and implemented for cause evaluations. Finally, senior management now reviews and approves root cause analyses.

- Improvements in Corrective Actions – The guidance on reviews of the effectiveness of corrective actions was improved to focus on verifying that causes have been fixed, and training was provided on the revised guidance. Additionally, the procedure was revised to require the use of safety precedence sequence (*e.g.*, corrective actions are determined with a preference for using design to minimize hazard; then safety devices; then safety warning; then procedures; and finally training and awareness) for correcting root causes. Additionally, at the Management Communication and Teamwork Meeting, the Management Review Board reviews CRs for applicable mode restraints, operating experience, and "good catches."

- Improvements in Timeliness of Corrective Actions – Daily meetings are currently held to provide management oversight of CRs and Corrective Actions coming due. Extensions and deferrals require management cognizance.

- Improvements in the Corrective Action Review Board (CARB) – The CARB is used to oversee the adequacy of analyses and corrective actions. The CARB has been improved in several ways. First, to provide additional leadership and pursuant to the CARB procedure, a plant Director or site Vice President is now chairing the CARB. Additionally, the reviews performed by the CARB have been expanded to enforce higher standards for cause evaluations and effective corrective action. The CARB uses indicators to show performance based on product reject rate. To meet CARB meeting quorum requirements, three members must be root cause trained.

In summary, the Corrective Action Program has been substantially upgraded. Based upon these upgrades and the improved performance in this area (as discussed in Section V.A.5), and pending final Program Review Board approval, Davis-Besse concludes that the CAP is ready for restart.

b. Operating Experience Program

Several improvements have been made to the Operating Experience program:

- In March 2003 FENOC implemented a new common policy for use of Operating Experience. The policy provides guidance on such matters as when to seek information on Operating Experience for use in proposed plant activities, where to seek the information, how to determine the validity of the information, and how to track the information for future updates and use.

- An Internal Lessons Learned Program was created to share selected Davis-Besse events with the staff and other FENOC plants. In addition, Perry and Beaver Valley events are shared with Davis-Besse.

- The Operating Experience Assessment Program was revised to evaluate Operating Experience documents through the use of CRs. The CAP is used to request extensions to evaluations.

- CARB oversees evaluations of NRC Information Notices and Institute of Nuclear Power Operations (INPO) SEE-IN documents.

- Operating experience information is now distributed to a larger population of plant personnel.

- Procedure guidance has been improved to now include specific responsibilities for the Davis-Besse staff.

- Several Operating Experience documents have been re-reviewed.

In summary, the Operating Experience program has been substantially upgraded. Based upon these upgrades Davis-Besse concludes that the program is ready for restart.

In Inspection Report 50-346/03-09, the NRC discussed its inspection of Restart Checklist Item 3.b, "Operating Experience Program." The NRC verified that the applicable regulatory, industry, and licensee guidance, as well as related CRs and corrective actions had been reviewed, and that significant issues affecting the program were identified. The NRC concluded that the overall corrective actions reasonably addressed significant program weaknesses identified by the licensee. Consequently, the NRC closed Restart Checklist Item 3.b.

c. Quality Audits

To address the shortfalls identified in the root cause analysis of QA discussed in Section III.C above, the following changes have been implemented:

- The Quality Assessment Manager at each station now reports to the Vice-President of Oversight, who in turn reports to the President of FENOC. The Vice-President of Oversight provides periodic updates of Oversight's concerns directly to the Nuclear Committee of the Board (of Directors) (NCOB). The Vice-

President of Oversight has unfettered access to the NCOB, independent of the Chief Nuclear Officer.

- The oversight board (*i.e.*, the Company Nuclear Review Board) is now governed by Nuclear Operating Procedure NOP-LP-2006. This procedure requires placing emphasis on nuclear safety, and specifies expectations for non-FENOC members, including independence from other assignments for the company.

- A process is in place to systematically review the source documents and attributes for the auditing process, in conjunction with the Continuous Assessment Process. The review captures recommended improvements throughout the course of a year, which then supports a formal annual update of the program.

- The organization has been changed so that Quality Control (QC) Inspectors report to the QA Manager. This improves the independence of the QC organization and its ability to assess field activities.

- The Quality Field Observation database has been revised to allow the inspection location to be readily recorded.

In summary, the quality audit program has been substantially upgraded. Based upon these upgrades and the improved performance of NQA (as discussed in Section V.A.4), Davis-Besse concludes that its quality audit program is ready for restart.

The NRC stated that it will close the associated Restart Checklist Item 3.c in Inspection Report 50-346/03-23.

d. Self Assessments

Davis-Besse procedure NG-EN-00386, "Program Assessment, Ownership, and Development," was created to ensure that plant programs remain strong in the future. This procedure provides guidance for developing, maintaining (owning), and assessing plant programs. The guidance also: (1) provides management expectations; and (2) facilitates the creation and preservation of strong programs that exceed regulatory and industry requirements and that have strong ownership, effective interfaces and handoffs, and reflect best industry practices and operating experience. One of the procedural requirements for program owners is to perform a program self-assessment every three years. In addition to these assessments, the procedure establishes requirements for more detailed assessments of programs selected by senior management. Criteria for selecting the programs to perform detailed assessments include input from plant performance, Quality Audits, industry experience, and regulatory schedules and performances.

Corporate program managers have been established to oversee several different disciplines, including design control, equipment reliability, and operations. These program managers facilitate the use of best industry practices. The program managers monitor indicators for their respective programs and perform industry benchmarking. These program managers provide added assurance that industry standards are maintained throughout the FENOC nuclear fleet.

In conclusion, procedural requirements have been established to ensure that programs continue to be assessed in the future to avoid undetected program degradation such that program ownership and implementation remain strong.

The NRC stated that it will close the associated Restart Checklist Item 3.c in Inspection Report 50-346/03-23.

e. Boric Acid Control Program

The BACC Program was thoroughly evaluated. Programmatic issues were documented on CRs; corrective actions (CAs) were generated to address the identified issues. A number of improvements have been made to the BACC Program. These improvements include:

- Developing and implementing procedure NOP-ER-2001, "Boric Acid Corrosion Control Program";
- Revising the BACC Program Manual and inspection procedure EN-DP-01500 to include the CRDM nozzles as a probable location of leakage;
- Revising NOP-ER-2001, to require the retention of the BACC Leakage Inspection and Periodic Monitoring Reports;
- Requiring the BACC Program Owner and System Engineers to document their review and approval of boric acid inspection reports;
- Hiring a new Davis-Besse BACC Program Owner and ensuring that individual has few, if any, collateral duties;
- Developing and implementing Job Familiarization Guideline TSM-115, "Boric Acid Corrosion Control Inspector," for the boric acid inspectors and the BACC Program owner;
- Expanding the scope of boric acid inspections to include selected Alloy 600 components and borated systems outside containment;
- Establishing a formal interface between the ISI and BACC Programs; and
- Increasing management oversight of the BACC Program.

The NRC reviewed the programmatic improvements (as documented in NRC Inspection Reports 50-346/03-09 and 02-11) and found that the BACC Program issues were properly resolved. In Inspection Report 50-346/03-17, the NRC concluded that the planned actions to address the remaining issues before restart were satisfactory. On July 22, 2003, the Davis-Besse IMC 0350 Oversight Panel concluded that the associated Restart Checklist Item 3.d was closed.

f. RCS Integrated Leakage Program

The RCS Integrated Leakage Program was developed, implemented, and subsequently reviewed by the Program Review Board. In developing this program, RCS unidentified leakage data from the last three operating cycles at Davis-Besse was used to determine methods of identifying trends and setting action levels.

As discussed with the NRC in a meeting on January 14, 2003, the program identifies various action triggers for adverse trends for unidentified leakage and for indirect leakage, such as containment activity, radiation elements, filter plugging, primary and secondary leaks. Data that exceed the trigger thresholds are documented in the CAP and evaluated for plant impact.

The action triggers for adverse trends are low to provide for ample time for implementation of remedial and preventive actions, including shutdown if warranted. Three different RCS leakage evaluation trends are obtained from the water inventory balance at least every 72 hours during steady state operation. The rate of change in the leakage rate is trended over a seven-day period. There are also trigger actions for step changes in leakage.

There are three trigger levels indicative of the increasing level of risk created by operating with low levels of leakage. Each trigger is associated with an action level that requires a more urgent response.

These trigger points have been used to perform a retrospective analysis of the 1996 to 2002 leakage data from Davis-Besse. The triggers or action levels provided in the program would have prompted the plant to take actions to resolve leakage in the summer of 1998.

As part of the program development, a program manual, Nuclear Group Program Procedure, program notebook, and an engineering implementing procedure were prepared in addition to revisions of several existing procedures. A new RCS Leakrate Sensitivity test was also prepared for obtaining data during the seven-day Mode 3 NOP hold period. This data was used to verify that the existing instrumentation could identify small induced (simulated leakage), quantifiable leak rates. This data was also used to verify the improved RCS Leakage computer algorithm against the current algorithm.

In summary, the RCS Integrated Leakage Program was designed to set industry standards for the identification and resolution of leakage. Based upon the improvements incorporated in this program, Davis-Besse concludes that the program is ready for restart.

In Inspection Report 50-346/03-09, the NRC discussed its inspection of Restart Checklist Item 3.e, “Reactor Coolant System Unidentified Leakage Monitoring Program.” The NRC concluded that, if properly implemented, the RCS Integrated Leakage Program represents a conservative and structured approach to detecting and responding to RCS leakage. Consequently, the NRC closed Restart Checklist Item 3.e.

g. Inservice Inspection Program

The Davis-Besse ISI Program is committed to the 1995 Edition through the 1996 Addenda of ASME Section XI as required by 10 CFR § 50.55a. The scope of the ISI Program includes safety-related ASME Class 1, 2, and 3 systems.

In addition to examinations required by the ASME Code, augmented examinations have been established for selected components. These augmented examinations include visual examination of RPV head control rod drive nozzles as well as examination of selected Alloy 600 connections.

Several improvements were made to strengthen the ISI Program, including:

- Establishing a formal interface between the ISI Pressure Test and the Boric Acid Corrosion Control Program;
- Establishing a hard link between the ISI Program and the BACC Program that requires ISI to acknowledge and ensure appropriate corrective actions on the BACC inspection results on components within the ISI inspection boundaries;
- Requiring pre-job briefs prior to in-service inspections to emphasize awareness of evidence of boric acid leakage and the requirements of reporting evidence of boric acid leakage in accordance with the BACC Program;
- Establishing performance indicators to monitor the long-term health of the ISI Program; and
- Improving training of Visual Examination Technique Category 2 examination personnel. The improved training emphasizes the requirements of IWA-5250 of ASME Section XI to identify the source of leakage and to determine whether any areas of general corrosion exist when leakage is noted.

The ISI program has been upgraded to establish a regimented structure to ensure that thorough and comprehensive examinations and tests are conducted to identify any boric acid leaks and confirm and maintain the pressure boundary integrity of ASME Class 1, 2, and 3 systems. Based upon the improvements incorporated in this program, Davis-Besse concludes that the program is ready for restart.

In Inspection Report 50-346/03-09, the NRC discussed its inspection of Restart Checklist Item 3.f, "Inservice Inspection Program." The NRC determined that the ISI Program review was a thorough, detailed, systematic review that identified several areas for program improvement. The NRC found that although "the ISI Program was not technically "broke" prior to this review, the identified enhancements should result in a more effective implementation." Consequently, the NRC closed Restart Checklist Item 3.f.

h. Modifications Program

A review of the Plant Modification Program was performed, which included a comprehensive evaluation of the primary and associated support procedures. During the program review two other significant activities were occurring with the Plant Modification Program. The process procedures were being replaced by the FENOC Common Process Nuclear Operating Procedure, NOP-CC-2003, “Engineering Changes.” Also, a Collective Significance Root Cause Evaluation for CR 02-02408 was being finalized. Although these activities were initiated independently of the Program Review, they were included in the review. The reviews provided recommendations for program controls and program implementation improvements.

The activities described above indicated that the Modifications Program was based on sound principles incorporating the necessary standards and requirements, both internal to FENOC and external. Specific areas addressed in the results are discussed below.

Two significant issues were identified during the Program Review:

- The wording in a seldom-utilized section of the Design Verification procedure did not meet the intent of American National Standards Institute (ANSI) N45.2.11, “Quality Assurance Requirements for the Design of Nuclear Power Plants.” Davis-Besse determined that the impact of using this procedure on previous engineering changes and installed plant equipment was negligible. The procedure was subsequently revised so that it conforms to the appropriate ANSI standards.

- The method used to prioritize and defer engineering changes was less than adequate. The Project Review Committee Business Practice, DBBP-BSA-0001, was revised to require full PRC concurrence on deferral of plant modifications.

As a result of the Modifications Program Review, the following improvements were made:

- Development of a common procedure within FENOC. The new procedure was modeled after the Electric Power Research Institute (EPRI) guideline for effective Engineering Change Processes, various industry best practices, and best practices among the FENOC plants. The process is based on a graded approach to modification development to ensure that the appropriate level of rigor and resources are applied, commensurate with the safety significance of the engineering change.

- Institution of a more formal design input process to identify and document pertinent design information at the beginning of the design development. This process is based on ANSI N45.2.11.

- Establishment of a comprehensive design interface and evaluation process. This design interface process includes a detailed checklist that prompts the responsible engineer to identify potentially affected disciplines and organizations across the site organization. This process is designed to obtain early involvement from affected organizations to minimize redirection and rework during the final review and approval stage of the design change. Included in this interface is an early identification of affected procedures or training activities.

- Implementation of the first phase of improvements in the post-modification review/closure process by including a requirement for field walkdowns by the responsible engineer and re-assigning the final document review to the Document Control group under Engineering. A procedural requirement to close the final Engineering package within 90 days after Operational Acceptance was also implemented.

In summary, the Modifications Program has been upgraded to conform with industry standards and provide enhanced controls of modifications (including deferral of modifications). Based upon these upgrades, FENOC concludes that the Modifications Program is ready for restart.

In Inspection Report 50-346/03-09, the NRC discussed its inspection of Restart Checklist Item 3.g, "Modification Control Program." The NRC concluded that the evaluation of the modification program adequately identified administrative deficiencies in the program, and that reasonable corrective actions were established to correct identified deficiencies. Consequently, the NRC closed Restart Checklist Item 3.g.

i. Radiation Protection

During the early stages of 13RFO, several steam generator contract workers were found to have left the Davis-Besse site with residual contamination in the form of "discrete radioactive particles." Because of this and other radiation protection program issues, the NRC's IMC 0350 Oversight Panel issued an update to the Restart Checklist on October 30, 2002, which added the radiation protection program to the Restart Checklist.

In response, both internal and external resources were employed to perform a systematic review of the Davis-Besse RP program. Included in this review were regulatory issues, INPO Best Industry Practices, and improved section efficiencies. A number of weaknesses in the program and its implementation were identified. The CAs for the more significant issues are discussed below.

Several changes to the Davis-Besse Radiation Protection Program staffing have been made, including the hiring of a new FENOC RP Program Manager (who is currently serving as acting site RP Manager) and several additional professional staff. These people have industry experience outside of FENOC. Improvements were also made to procedures and policies. New and improved standards and expectations have been established and delineated in the conduct of radiation protection, including implementation of INPO's human performance improvement criteria. Professional behaviorist and consultants were brought in to work with the section to strengthen behaviors, teamwork, and safety culture.

Senior management communicated expectations that resulted in improved ownership of radiological issues. Increased and improved communications with the entire station focused on improving radiological behaviors and the practices of workers. Additionally, state-of-the-art instrumentation and equipment have been purchased and placed into service. This has improved personnel and equipment monitoring for better radiological control.

Several teams of radiological personnel visited other nuclear plants throughout the United States to benchmark and incorporate beneficial practices. Training was provided using several different methods from just-in-time training, and mockup training to formal classroom training. The recent assessment of radiation protection during the NOP test concluded that Radiation Protection support for Operations was excellent.

In summary, significant improvements have been made to the Radiation Protection section, including implementation of lessons learned from the discreet radioactive particle event, and expanding the scope of that review to other areas of the program. Improved radiation protection policies, procedures, and training of the staff are complete, and new state-of-the-art monitoring equipment is installed. As a result, Davis-Besse concludes that the Radiation Protection program is ready for restart and safe operation.

The NRC has completed inspections into the uncontrolled release of radioactive material and the intake of radioactive material by steam generator workers. Those inspections are documented in NRC Inspection Reports 50/346/02-16 and -06. The NRC also conducted a supplemental inspection to evaluate the root cause investigation and corrective actions into the Radiation Protection program deficiencies. The supplemental inspection is documented in NRC Inspection Report 50/346/03-08. The NRC concluded that the completed and planned corrective actions were appropriate.

In addition, because there has been a series of changes in Radiation Protection management personnel during 13RFO, the NRC evaluated the effectiveness of management oversight of the Radiation Protection program in Inspection Report 50-346/03-17. The NRC concluded that management oversight of radiation protection had improved and was capable of supporting plant restart. Consequently, the NRC closed Restart Checklist Item 3.h, "Radiation Protection Program."

3. Conclusions

Davis-Besse has the following objective for programs: *Programs comply with NRC regulations, incorporate applicable operating experience, and are effectively implemented. Personnel take ownership of programs within their scope of responsibility, and program owners ensure that the objectives of their programs are achieved.*

Actions to achieve this objective include the following:

- As discussed above, the Program Compliance Building Block Plan, which provided for a two-phase review of programs, was developed and implemented.

- On a long-term basis, follow-up assessments of programs will be performed using the Focused Self-Assessment program with criteria similar to those used in the Phase 2 restart program reviews. This process will provide for a standard review of the Davis-Besse programs.

- Common processes applicable to all FENOC plants will utilize recognized best practices. The common processes will apply to those areas that are amenable to a common process (*e.g.*, corrective action). Plant-specific procedures and processes will continue to be used in those areas that are unique to Davis-Besse (*e.g.*, plant-specific procedures will be used for operating procedures that pertain to Davis-Besse design-specific areas). The FENOC Common Process program will facilitate benchmarking and obtaining good industry practices for use at all three FENOC sites.

- A corporate organization has been established with responsibility to develop standard processes applicable to all FENOC nuclear units and assess the effectiveness of their implementation. Program Managers are assigned to work on program standardization and effectiveness on a fulltime basis. These managers are charged with determining industry best practices in their assigned area of concentration, working with plant peers to integrate these practices into FENOC processes, and following up to assure that implementation has been achieved and is effective at each FENOC site.

Davis-Besse has verified that the efforts to improve its programs have been effective. For example, Davis-Besse has a performance indicator for Program and Process Errors that measures undesirable situations caused by the lack of information in programs or processes for the performer to complete the task or evolution successfully. The program error rate is the number of program and process errors per 10,000 person-hours worked. The restart goal for this indicator is a 12-week rolling average < 0.50 program errors per 10,000 hours. As of November 9, 2003, the value for this indicator as a 12-week average is 0.24 program errors per 10,000 hours worked. Furthermore, the performance has consistently met the goal.

In summary, Davis-Besse concludes that:

- The programs at Davis-Besse comply with NRC regulations, incorporate applicable operating experience, and are effectively implemented; and

- Personnel take ownership of programs within their scope of responsibility, and program owners ensure that the objectives of their programs are achieved.

As of November 9, 2003, over 600 CRs and 650 restart corrective actions for programs have been completed, and only two restart corrective actions remain open. Based upon its reviews and corrective actions, Davis-Besse concludes that its programs are ready to support safe and reliable operation.

E. System Health Assurance Plan

The purpose of the System Health Assurance Plan was to perform reviews of plant systems prior to restart to ensure that the condition of the plant is sufficient to support safe and reliable operation.

1. Initial Scope of the System Health Assurance Plan

The initial scope of the System Health Assurance Plan included the following levels of system reviews:

Operational Readiness Reviews

The Operational Readiness Review was performed to identify whether systems have significant shortcomings, and to initiate immediate actions to correct those problems. Systems for review were selected considering system performance relative to the Maintenance Rule performance criteria, material condition, and operator burdens.

System Health Readiness Reviews

System Health Readiness Reviews were performed on risk-significant Maintenance Rule systems not covered by the more extensive LIR process. These reviews were more in-depth than the Operational Readiness Reviews and were focused to provide reasonable assurance that these systems can perform their risk-significant Maintenance Rule functions. These reviews included identification of each system's risk-significant functions, reviews of testing or review of other information (such as trending data) that assesses the system's ability to support risk-significant functions, walkdowns, and reviews of selected data sources. Problems identified during the reviews were captured in the CR process. The RSRB reviewed the CRs to determine if there were restart requirements.

Latent Issues Reviews

LIRs of the RCS, auxiliary feedwater, emergency diesel generators, service water (SW), and component cooling water systems were performed. The primary focus of these reviews was to provide reasonable assurance that these systems are capable of performing their safety and accident mitigating functions. These reviews included verification of the design basis functions of the systems and were comprised of assessment of system attributes, review of various data sources, and walkdowns.

Results

Numerous discrepancies were identified by the System Health Readiness Reviews and the Latent Issue Reviews. These discrepancies included hardware-related conditions, inconsistent or potentially non-conservative assumptions in design and licensing basis documents, missing or unavailable calculations, operating and test procedures not reflecting the design documents, and documentation problems. These were documented on CRs in accordance with the Davis-Besse CAP.

The CRs were evaluated for collective significance and the results of the evaluation were documented in the Collective Significance Report. An evaluation of the potential safety consequences associated with the conditions identified during the reviews was also performed to determine if there could have been significant consequences had an accident occurred. This evaluation identified a number of conditions with potential safety significance. Based upon these evaluations, Davis-Besse determined the potentially safety-significant issues pertained largely to calculations. The quality and maintenance of calculations that constitute the design basis of the plant were found to need improvement. Based upon these results, the initial scope of System Health Assurance Reviews was expanded, as discussed below.

The System Health Assurance Reviews also included inspections of systems containing boric acid outside of containment to check for signs of leakage and boric acid degradation. Systems outside containment were inspected pursuant to procedure EN-DP-01506, "Borated Water System Inspections (Outside Containment)." Boric acid leaks were documented on CRs and evaluated under the BACC Program. More than 250 CRs and 700 CAs were categorized as "Required for Restart."

2. Expanded Scope of System Health Assurance Reviews

As shown in Figure 3 on page 52, the approach for resolving the design-related conditions identified from the initial scope of the System Health Assurance Reviews consisted of three paths.

Path A – Resolution of Conditions and Determination of the Extent of Condition

Condition Reports were evaluated for the potential effect on the operability of the plant's SSCs. Those identified conditions that did not affect operability and were not classified as a potential restart restraint were prioritized and scheduled for resolution after restart of the plant. For conditions affecting operability, corrective actions were taken or will be taken. Additionally, an evaluation was performed to determine whether the extent of condition (EOC) was bounded by the scope of another activity being implemented by Davis-Besse, such as the SFVP under Path B, the Design Basis Validation Program (DBVP) performed in the late 1990s, or the actions to resolve the potential programmatic issues under Path C. If not, an EOC review was performed. If the EOC reviews identified other conditions affecting operability, then those conditions were also addressed.

Path B – Evaluations to Provide Additional Assurance of Significant Safety Functions Capabilities

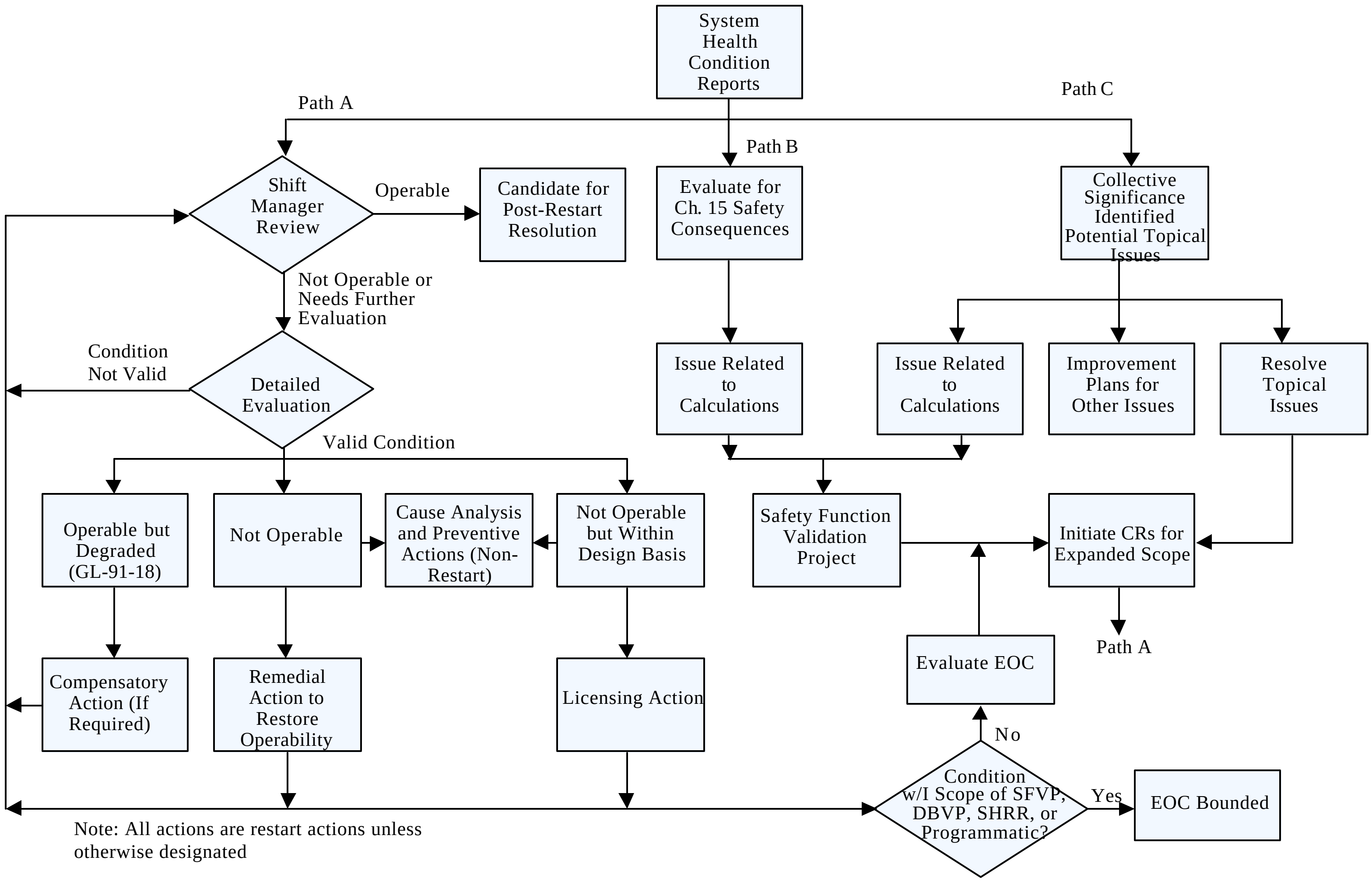
As a result of the calculation issues identified during the LIRs, further reviews of calculations were conducted to provide additional assurance that Davis-Besse systems are capable of performing their safety functions. These reviews consisted of an evaluation of the calculations for those systems with safety-related functions that contribute significantly to risk. This approach consisted of confirming that design basis calculations demonstrate safety function capability or that applicable tests are performed which demonstrate safety function capability. This review was performed under the SFVP. The scope of the SFVP included those systems with safety-related functions that contribute greater than one percent of the total baseline CDF as determined by the Davis-Besse probabilistic safety assessment (PSA). These systems include the systems that were already the subject of the LIRs plus 10 other systems: 125/250-volt DC, 480-volt AC, 4,160-volt AC, high pressure injection (HPI), decay heat/low pressure injection (DH/LPI), heating, ventilation, and air-conditioning (HVAC) for emergency core cooling system (ECCS) equipment, main steam (MS), safety features actuation system (SFAS), steam and feedwater rupture control system (SFRCS), and the steam generators (SG). The systems selected also provide assurance of the adequacy of the plant safety functions that provide a combined 99 percent contribution to LERF.

Path C – Resolution Of Design-Related Programmatic Issues

The collective significance of the conditions identified by the system reviews was evaluated to determine if any potential issues were identified in more than one system and, therefore, might reflect the need for process, programmatic, or product improvements. Conditions that were identified during the System Health Assurance reviews were sorted and placed into topical bins. An evaluation was then performed on the set of identified potential issues in each of those bins to determine their potential for collective significance. The evaluation considered several factors, such as the number of identified potential issues in each bin, the ratio of the number of identified potential issues to the number of times the topic attribute was checked by the LIR, and whether a potential issue was identified by more than one system review.

The evaluation identified approximately 20 topical areas where the potential collective significance warranted further evaluation. Many of the identified questions and potential issues related to calculations; others related to programmatic areas such as HELB, EQ, seismic, Appendix R - safe shutdown, flooding, and other potential issues that pertained to various other topics. The potential programmatic issues involving HELB, EQ, seismic, Appendix R – safe shutdown, and flooding were not within the scope of the DBVP. As a result, actions were taken to address these potential programmatic issues, including determining their extent of condition, as appropriate. Finally, the Collective Significance Report identified potential weaknesses in other topical areas beyond the calculation and programmatic issues discussed above. These areas do not directly impact the operability of plant SSCs and therefore do not require resolution prior to restart.

FIGURE 3 - - RESOLUTION OF ISSUES



3. Results

The SFVP system reviews determined that four (HPI, MS, SFAS, SG) of the 10 systems could perform their safety functions, three (DH/LPI, HVAC-ECCS, SFRCS) had some safety functions that could not be validated, and the three electrical systems (125/250V, 480V, 4,160V) were determined to be indeterminate based on available information.

As a result of the topical area reviews, a number of actions have been taken, including the following:

- Environmental Qualification – Modifications were made to four level transmitters with excessive bend radii of Raychem splices and unqualified splices in containment motor-operated valves.

- Seismic – Piping in the ECCS rooms and component cooling water (CCW) pump room was reviewed; no additional seismic issues were identified. General Electric HFA relays were tested for potential chatter and adjusted as required. Three pressure instruments found to have improper pressure retaining qualifications were replaced and a review was performed to identify other instruments to ensure that they have the proper qualification for pressure boundary integrity.

- Flooding – Piping in the ECCS rooms and CCW room was reviewed for additional Seismic II/I flooding concerns; none were found. Conduits that penetrate the external wall of the service water and diesel fire pump rooms are in the process of being sealed.

- HELB – An evaluation of the environmental effects of Turbine Building HELBs was performed. In accordance with Engineering Change Request 02-0627-00, equipment in the Auxiliary Feedwater Pump Turbine Rooms was modified to comply with EQ requirements. Also, high-energy piping analyses reviews identified five calculations in which stress thresholds were inappropriately used. Only one of the calculations resulted in amended results when the appropriate criteria were applied. Subsequently, that calculation was corrected and necessary plant modifications were implemented. Finally, a walkdown of the Auxiliary Building was performed to confirm free space volumes and examine openings. No deficiencies requiring corrective action prior to restart were identified.

- Appendix R Safe Shutdown Analysis – Framatome performed a rebaselining of the Appendix R transient analysis. Additionally, a sample of electrical distribution calculations credited in the Fire Hazards Analysis Report was evaluated to verify the adequacy of electrical coordination for Appendix R. No examples of inadequate coordination were identified.

In accordance with Path A of its plan for resolution of design issues, more detailed evaluations were conducted of the issues identified by the System Health Assurance Reviews (including the LIRs, Safety Function Validation Project, and Topical Area Reviews) to determine their impact on operability. Based upon the evaluations, it was determined that the 15 systems that were reviewed in detail (comprising 99 percent of the CDF and LERF) could perform their safety functions, with several exceptions. For example:

- RPV Head (LER 2002-02) – As discussed above, through-wall cracking of the CRDM penetrations and corrosion of the RPV head was identified. As a result, the RPV head was replaced, EOC walkdowns inside and outside of the containment were conducted to identify whether other components might be similarly affected, and corrective actions for such components were taken.

- Tornado Missile Protection (LER 2002-006) – It was determined that some of the emergency diesel generator (EDG) exhaust piping was not protected against tornado missiles. Additionally, it was determined that an exterior door for the main steam line room was not adequately protected against tornado missiles. The Davis-Besse plant site was walked down to identify other unprotected SSCs associated with the systems necessary to function in the event of a tornado. A revised evaluation methodology has shown these conditions to be acceptable.

- Air Operated Valves (LER 2003-001) – An AOV Reliability Program was implemented to verify AOV actuator sizing and setpoints. As a result of this program, some AOVs were identified that could not perform their safety function. Corrective action is being taken for these valves, including modifications to install new valve actuators and new accumulators as necessary to restore operability.

- High Pressure Injection (HPI) Pumps (LER 2003-002) – It was determined that the HPI pumps could be adversely affected by debris in the containment emergency sump water during operation of the pumps in the recirculation mode. The pumps are being modified to operate with the remaining debris. Other pumps (*e.g.*, low pressure injection pumps, containment spray pumps) that might be adversely affected by the same condition were also evaluated, and it was determined that they could adequately perform their safety functions.

- Minimum HPI Recirculation Flow (LER 2003-003) – During its inspections in parallel with the System Health Assurance Reviews, the NRC identified the minimum flow protection for the HPI pumps might not be sufficient to protect the pumps against damage during certain small break loss of coolant accidents. Additional minimum flow recirculation lines have been installed to correct this condition.

- Electrical Distribution System (LER 2003-007) – It was determined that the Davis-Besse electrical distribution system (EDS) calculations were not sufficient to verify the function of the EDS. Many of the unvalidated functions in the 480V and 4,160V systems were related to deficiencies in the Electrical Load Management System (ELMS) calculation. To address these and other deficiencies, the ELMS calculation was replaced with a new Electrical Transient Analysis Program (ETAP) - based calculation. Based upon the results of the ETAP calculations, it was determined that the EDS could not perform its function in certain system alignments and conditions involving the simultaneous occurrence of low grid voltage and a loss of coolant accident. As a result, modifications are being implemented and administrative limits established to ensure that sufficient voltage will be available for essential components. Several of these modifications and administrative limits have not yet been closed out, but are scheduled to be so before entry in to Mode 4.

In addition, several values in the Technical Specifications for the SFRCS and the SFAS were found to be non-conservative. Administrative controls have been implemented to ensure that appropriate values are used. A license amendment request (letter Serial Number 2960, dated August 25, 2003) has been submitted to revise the SFRCS Technical Specifications values. The request for revisions to the SFAS Technical Specification values will be submitted to the NRC prior to January 30, 2004. Consistent with NRC Administrative Letter 98-10, "Dispositioning of Technical Specifications that are Insufficient to Assure Plant Safety," administrative controls can be utilized until the NRC approves these license amendment requests.

In addition, as a result of an initial evaluation of a change to accept as-is the emergency diesel generators' actual frequency and voltage transient values during the automatic loading sequence, it was determined that a license amendment request was required to change the USAR's description of these values. That license amendment request is under preparation and will be submitted to the NRC prior to January 30, 2004.

It was also identified that an exemption request must be submitted to the NRC to credit the new Boron Precipitation Control (BPC) method in accordance with 10 CFR § 50.46. In the meantime, the two previously existing credited BPC methods are available. It was also determined that an exemption request will be submitted to the NRC for a fire area found to be lacking full fire suppression capability. Until that request is approved, compensatory measures (*e.g.*, hourly fire watches) will be maintained. Both of these requests will be submitted post-restart.

Finally, Davis-Besse recently issued a Systems Health Report for the third quarter of 2003. This report rated the overall system health as "Yellow," largely because corrective actions were still in progress for a number of systems in the Maintenance Rule (a)(1) category. System owners have presented their improvement plans to management, and improvement actions are being implemented. As a result, it is expected that, prior to restart, the categorization of the existing "Red" systems will improve to "Yellow" or better, with the exception of the Radiation Monitoring and Heat Trace/Freeze Protection Systems (which will have outstanding preventive measures to improve equipment reliability that are not necessary for restart). Based upon the overall improvement actions, it is expected that overall System Health will improve from "Yellow" to "White" prior to restart.

4. Conclusions

The System Health Assurance Reviews were performed to verify the safety functions of 15 systems whose functions comprise 99 percent of CDF and LERF. As a result of these reviews, it was determined that most of the safety functions could be performed. It was determined that some conditions adversely affected the safety functions of several systems. In those cases, corrective actions have been or will be taken to restore the functionality of the systems, and reviews were performed to bound the extent of condition. Furthermore, as of November 21, 2003, almost 1,500 restart corrective actions related to system health have been completed, and less than 20 restart corrective actions remain open. As a result, Davis-Besse concludes that there is reasonable assurance that plant systems can perform their design basis safety functions and are ready to support safe restart and operation of Davis-Besse.

F. Management and Human Performance Excellence Plan

As discussed in detail in Section V below, the purpose of the Management and Human Performance Excellence Plan was to conduct a thorough assessment of the management and organizational issues surrounding the degradation of the RPV head and create a comprehensive leadership and organizational development plan for the site. The Plan consisted of three elements:

- Reviews and assessments;
- Collective significance review; and
- Specific actions to take before and after restart to ensure changes are effectively implemented.

Using data from the root cause reports and other assessments associated with the RPV head degradation, the primary management contributors to this failure were categorized into the following five areas:

- Management/personnel development;
- Nuclear safety culture;
- Standards and decision-making;
- Oversight and assessments; and
- Programs/corrective action/procedure compliance.

A Management and Human Performance Improvement Plan was prepared and implemented to address each of these areas. These improvements are summarized in Section V.

The Management and Human Performance Excellence Plan also included Functional Area Reviews of four organizations. The results of these reviews are summarized below.

Results

The following findings were made as a result of the functional area reviews:

- Work Control (Self-Assessment Report OMWC 2002-0001) – The Work Control organization was found to be ready for restart. A strength was identified regarding management making it clear that nuclear safety is the overriding priority. Areas for improvement were identified with respect to monitoring contractor performance, improving leadership, and enforcing the levels of performance established for the group. The first issue was addressed by corrective actions such as increasing the use of field observations by project managers and weekly meetings between contract supervisors and FENOC management. The second issue was addressed through a comprehensive Work

Management Organizational Development Plan and providing feedback to managers on leadership.

- Chemistry/Radiation Protection (Self-Assessment Report 2003-0003) – Eleven areas for improvement were identified. Only one of these was a restart item (*i.e.*, the RP improvement plan). These improvements in RP are discussed in Section IV.D above.

- Operations (Self-Assessment Report 2003-001) – Seven strengths were identified in the areas of safety culture, leadership and accountability, management direction and expectations, self-evaluation, corrective action, benchmarking, and use of operating experience. Areas for improvement were identified with respect to staffing resources and performance monitoring. In response, Operations issued a staffing plan to develop additional licensed operators and issued improved performance indicators.

- Maintenance (Self-Assessment Report 2002-0099) – Three strengths were identified with respect to a safe work environment, nuclear safety expectations, and problem identification. Eight areas for improvement were identified in areas such as benchmarking, corrective action, self-assessments, and leadership. None of these was designated as a restart item, and many involved issues addressed above (*e.g.*, Work Management Organizational Development Plan) and other sections of this report. As a result, the Maintenance group was found to be ready for restart and safe operation.

In summary, the functional area reviews generally found that the organizations were ready for restart and safe operation, but did identify areas for improvement among the organizations. Corrective actions have been taken for those areas designated as restart actions. Additionally, as discussed in more detail in Sections V.B and V.C, some shortfalls were identified in Operations during the NOP test in September 2003, and actions are being taken to address those issues.